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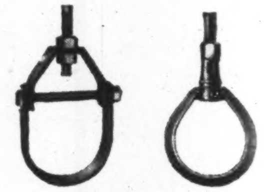
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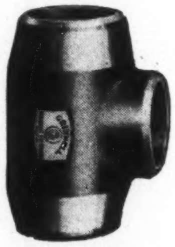
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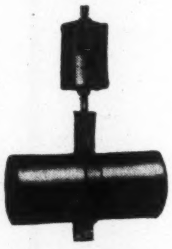
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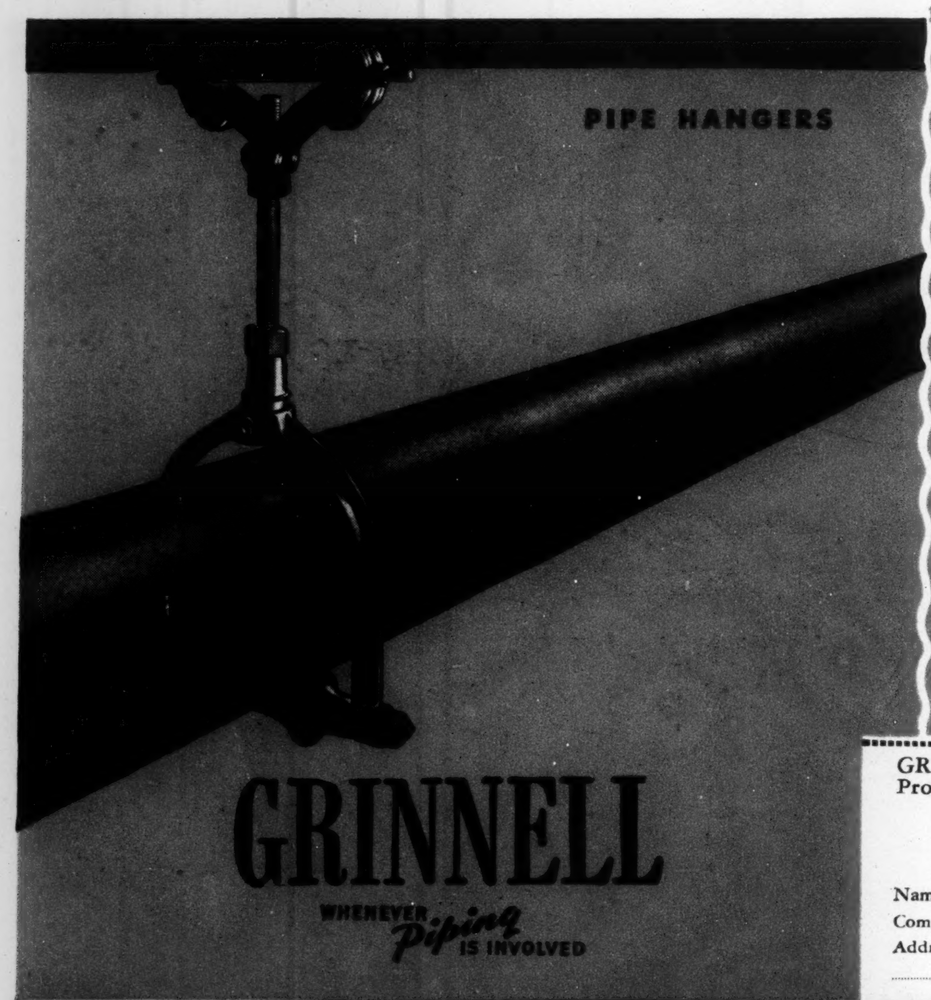

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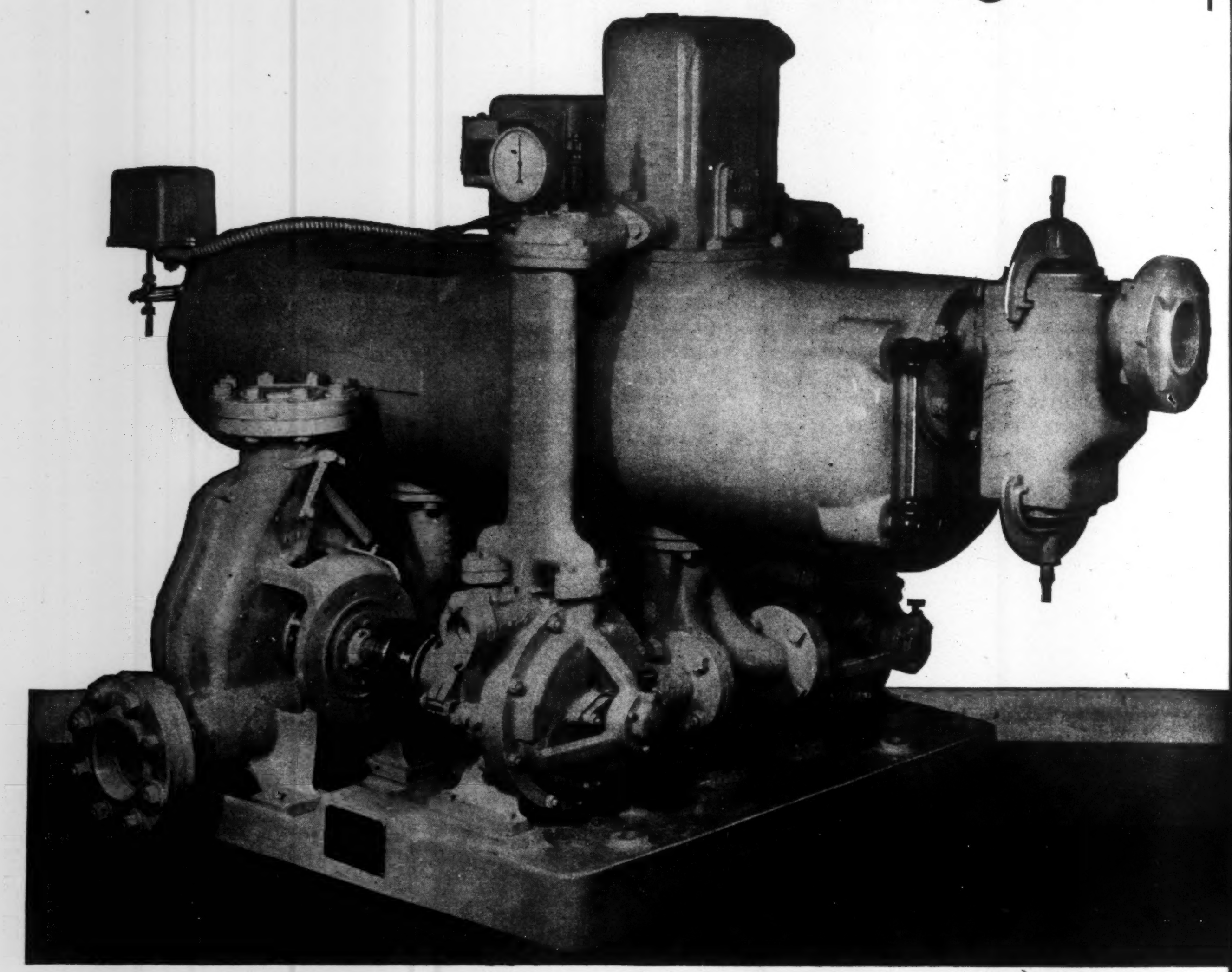
Where Heat Must Not Fail—
Install this SAFE Heating Pump



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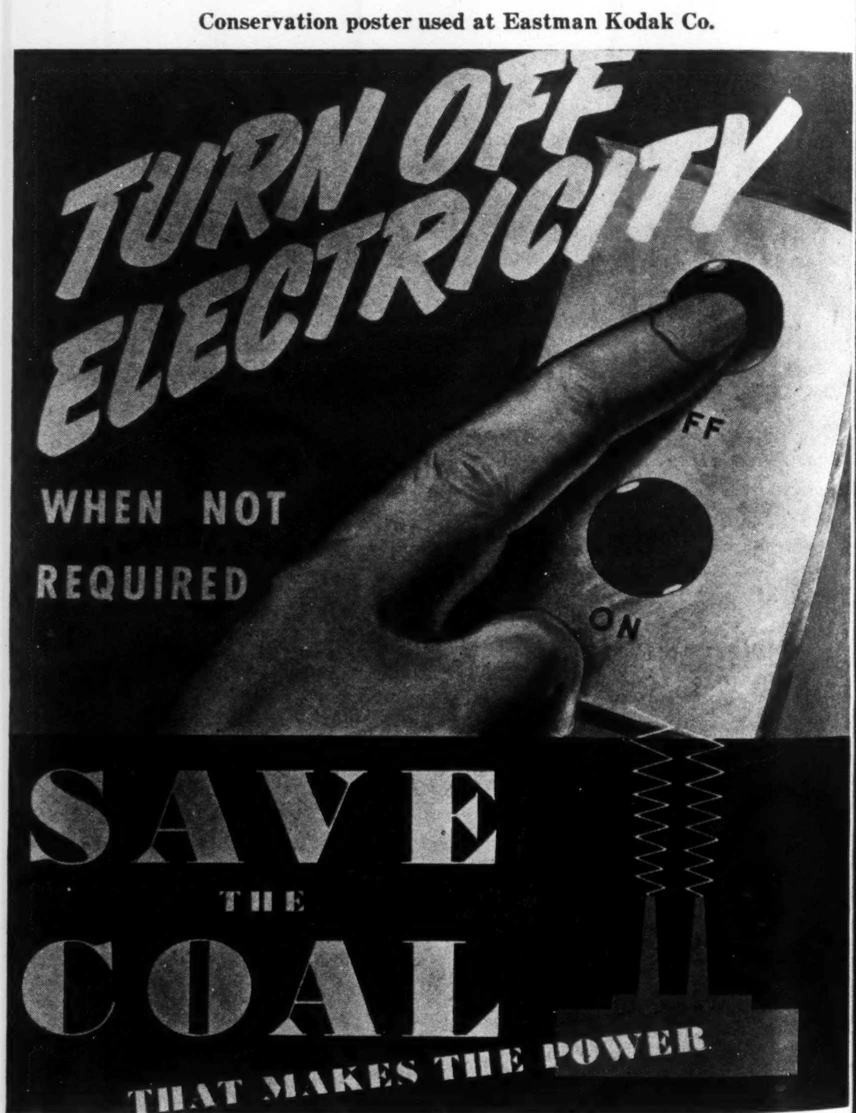

38 MILLION TON COAL SHORTAGE SEEN

Fuel Efficiency Drive Can Save 29 Million Tons, Says Dr. Sayers at Smoke Prevention Association Meeting . . . Organization of National Fuel Efficiency Program Explained and Names and Addresses of the Coordinators Given . . . Your Cooperation Requested

**COAL IS AMMUNITION
DO NOT WASTE IT**

ESTIMATED PRODUCTION of coal r the year April 1944 through arch 1945 will fall 38 million ns short of the estimated re-irements, Dr. R. R. Sayers, Di-ctor of the Bureau of Mines, clared at the annual meeting of e Smoke Prevention Association America held in Detroit last onth. Dr. Sayers said that the lid Fuels Administration for ar has estimated the national re-irement for bituminous coal to 626 million tons this year, and at we probably will be able to rn out only 596 million tons. The oduction goal for anthracite has een set at 65 million tons, but ac-al production—according to latest FA figures—will probably be earer 57 million tons, he said.

29 Million Ton Saving

"The Bureau of Mines believes at at least 29 million tons of this ortage of 38 millions can be rased simply by eliminating the eed," he continued. "In other ords, the belief is that industrial-mmercial users of coal, aided by chnical assistance of the bureau d of volunteer engineers from in-ustry, can cut their fuel needs 29 illion tons of coal simply by using e equipment on hand more effi-ently, by maintaining the equip-ent in such a manner that it will rn out as much work, or more, and still use less fuel. We are aiming, too, at proportionate savings in fuel oil, gas, coke; in fact, all the common fuels. It will require the help of every person using fuels in commercial quantities to meet this challenge. The bureau thus has formed the National Fuel Efficiency Section to provide scientific and technologic assistance to industry."

The National Fuel Efficiency Program, conducted in cooperation with the Bureau of Mines, is headed nationally by a council of which Thos. C. Cheasley, Supervising Engineer, National Fuel Efficiency Section, Bureau of Mines, Washington 25, D. C., is chairman. The other members of this council are O. F. Campbell, W. G. Christy, C. F. Hardy, H. K. Kugel, L. S. Reagan, C. A. Reed, R. C. Johnson, R. A. Sherman, A. W. Thorson, J. E. Tobey, and J. F. Barkley.

Coordinators have been appointed to conduct the program in various areas throughout the country; each coordinator is assisted by an advisory council. Each coordinator may plan his campaign in the way he feels is best for his particular area, so that the organizational setup for the respective areas varies somewhat. In general, there will be sub-coordinators, committee chairmen, or district chiefs each responsible for some geographical part of a metropolitan area, or the work may be split up according to classifications of industry and business—all hotels in one group, schools in another, etc.

Under the coordinator for each area and his advisory council and other assistants come the regional engineers who actually call on the plants and buildings to explain the program, ask for cooperation, check the opportunities for fuel savings, etc. There is to be a "waste chaser" appointed in each plant or building who will be charged with promoting fuel conservation efforts in that particular plant or building.

A Voluntary Effort

It cannot be stressed too strongly that the entire National Fuel Efficiency Program is a voluntary effort—the coordinators, their advisory councils, the regional engineers, and the others all serve without pay.

Mr. Cheasley told the members of the Smoke Prevention Association that he felt sure that if the necessity for the fuel efficiency program and an explanation of its aims are personally carried to the executives of industrial and commercial establishments and are properly presented, that "there will be no need to worry about their participation." He urged each member of his audience to make direct

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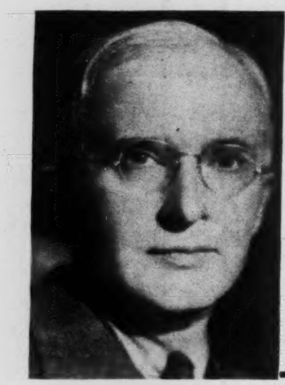


Sam Lewis' Page

In this regular feature, informal comment on heating, piping, and air conditioning problems and their solutions is given — at the request of the editors — by Samuel R. Lewis, consulting engineer, and a member of HPAC's board of consulting and contributing editors

MANY YEARS ago I went wholeheartedly off the "or equal" standard in writing specifications. Hardly anything in this unfortunate world is the equal of anything else.

No good salesman of pedigreed equipment used in the heating, ventilating, and air conditioning of buildings will admit that his particular equipment is or can be equaled by that of his competitor. The salesman who claims to have the "equal" equipment usually is found to be promoting something less costly or smaller or less efficient than the desired standard.

A consulting engineer is paid for engineering advice by the owner. He is also paid by the owner to furnish protection against acceptance of materials and equipment from the contractor that are less valuable than those which the owner expected to receive when he signed the contract. The engineer also is obligated to protect the contractor against any unfair demand by the owner.

Many years ago when designing the heating and ventilating equipment for public schools I adopted the rule of specifying for each major item a standard make, insisting that all bidders submit tenders based on the named standard, and inviting them to bid also on any other makes that pleased them, stating the difference in price from the standard, if any difference existed.

Thus if, upon investigation, it appeared desirable to accept a substitution either at a higher or lower cost, such substitution easily and fairly could be arranged at the time of entering into the contract. A history of many years use of this plan shows that frequently the equipment alternately submitted was accepted—often at substantial savings.

Since in many states on public buildings the lowest bidder must receive the contract, this bidder could be selected in fairness to all, on the basis of the standard equipment, and if then it appeared wise to purchase an alternative material the owner, advised by the engineer, and cognizant of all the circumstances, could receive the benefit of better apparatus or of reduced costs.

This arrangement of the specifications has been tested and vindicated in the Ohio courts. It is acknowledged that it removes from the general contractor the dubious benefit of a secondary competition under which profits for himself, not shown in the original bidding, could be chiseled from his sub-bidders.

The term "general contractor" used herein means any contractor who combines the bids of various subcontractors.

It seems fair that the owner shall know what makes of material shall be furnished for the dollars he appropriates and fair that the subcontractors shall receive the dollars for their equipment that were contemplated when their prices were assembled by the general contractor.

A standard substitution clause, used many times, is as follows:

"Certain definite makes of material or apparatus are specified as standard. The contractor shall bid on the basis of furnishing the makes specified. He is invited to bid also on any other equal or similar makes he may desire to substitute, in which event, if it is decided by the owner to accept such substitution, the specifications will be amended prior to the award or signing of the written contract. Where several makes of material or apparatus are mentioned, and the contractor fails to state in his bid that he prefers any particular material or apparatus, the owner shall have the right to choose any of the makes mentioned without change in price."

* * *

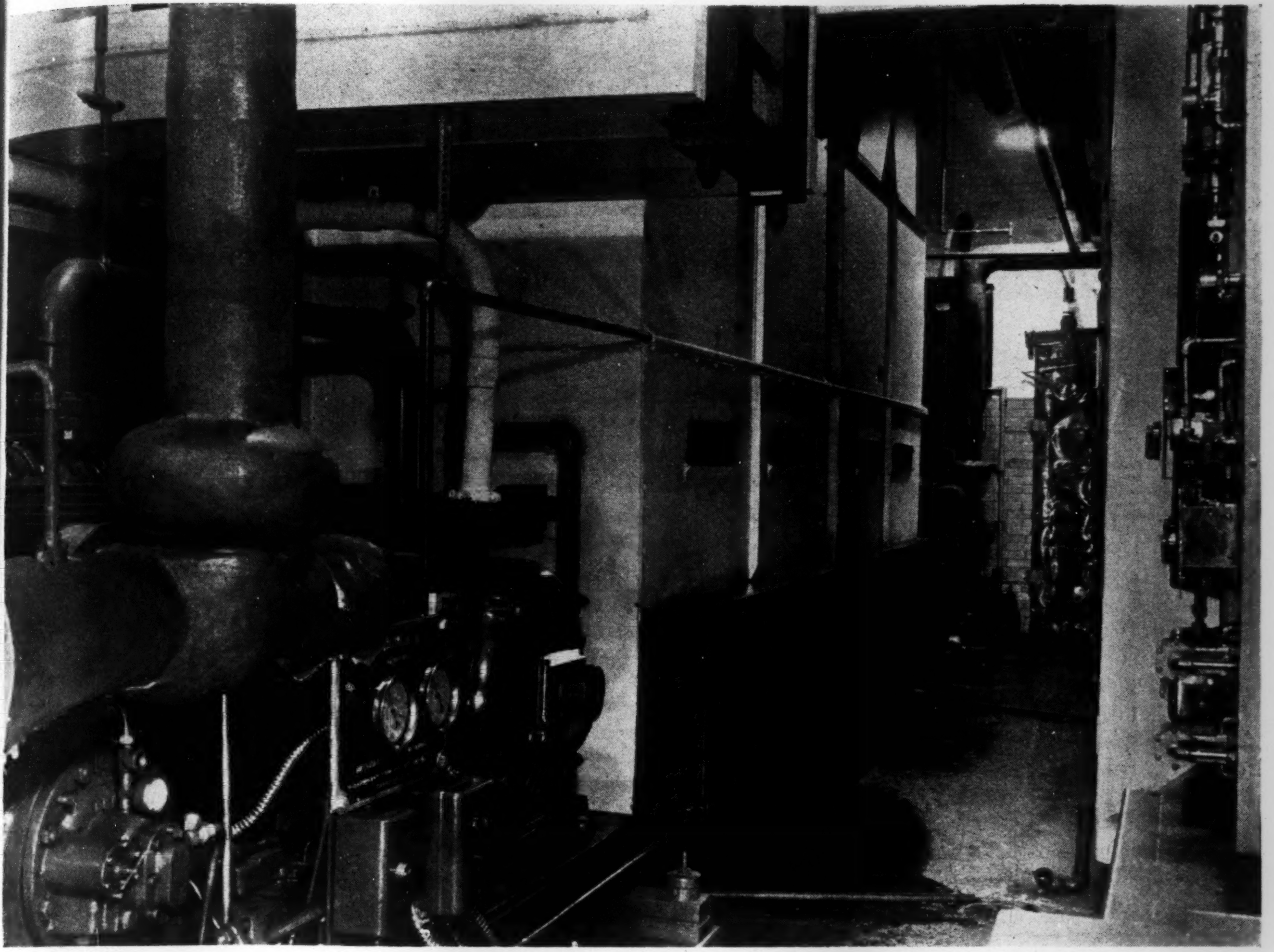
ONE OF the things which has been impressed on the face of industry by some of the patriotic regimenters in Washington is that the specifications for government work must use or must not use certain time-honored clauses and expressions.

For example, sparing use of the term "furnish and erect" as cited on one large Army contract is to my mind constructive and saving in ink and paper.

Another custom, insisted upon in many housing projects is the use of letters and numbers as subindices, ad nauseam, of which the following is not too exaggerated an example:

"12. *Suspenders*
  a. The color must be blue
    1. The blue must be non-fading.
  b. The button holes must be reinforced
    1. With cotton thread twisted left hand.
    2. Must be cut with shears."

This results in much confusion between the "12" and the "a-1" which frequently is extended to twelve or more items.



Jahco is "sold" on air conditioning of industrial plants as an aid to production

Heating and Air Conditioning Problems at Busy War Plants

JACK & HEINTZ, INC., Cleveland, Ohio, manufacture equipment for the Army Air Forces—generators, directional gyro indicators, automatic pilots, hydraulic surface controls, gyro horizon indicators, starters, etc. The motto of the "Jahco Associates" is "one for all and all for one," and Bill Jack's aim has always been that the organization should operate on the basis of the Golden Rule. His philosophies of production, management, and labor relationships have made it possible for the associates to work an 84 hour week and thrive on it, and the plants have broken all sorts of production and cost records.

Informality is one of the house rules at Jahco, first names being used throughout the organization. Everyone is an "associate," from Bill Jack and Ralph Heintz to the newest floor sweeper. There are few if any time clocks (but you get the "wolf call" from your fellows if you're late, which is said to be a trying experience), and the aim is to cut red tape in management and labor relations to a minimum. As aids to production efficiency, the company furnishes (at company expense) well-fitted shoes to all the associates, because it is felt that a man—or woman's—best work can't be done unless his—or her—feet are comfortable. Each of the associates is given a substantial hot meal at noon, again at company expense and again for the sake of efficiency in production. There are coffee urns throughout the plants and offices, smoking is permitted any time and in any place where it isn't dangerous, and rules and regulations are conspicuous by their absence. Continuous music is provided over a public address system, which is used also for talks by Bill Jack direct from his office, daily newscasts, announcements, etc.

Magazine writers, radio commentators, and other visitors to Jahco have discussed the significance of these and other innovations on plant output, production efficiency, and labor-management relationships. On a recent visit to two of the plants, I was interested particularly in the air conditioning, heating, and ventilating installations and jotted down a few notes about them. Bob Clark, who is responsible among other things for the functioning of this equipment, showed me around and answered my questions, but the following notes and comment are my own.

Sold on Air Conditioning—Jahco is apparently "sold" on complete air conditioning of industrial plants as an aid to production efficiency by keeping workers comfortable no matter what the weather and the heat gains from production equipment and lighting may be. I got the impression that, were it not for wartime restrictions and material shortages, practically the entire plant and the offices would be completely air conditioned. Offices built before the war are conditioned, and of course there are numerous air conditioning systems serving various rooms and departments—such as gage rooms—in the plant where controlled temperatures and humidities are essential. For the protection of gages against corrosion, humidity must of course be limited in the rooms where they are kept and used, and temperature must be maintained at a constant value to insure the accuracy of the gages. Automatic recorders in each such room give a continuous check of the air conditions maintained.

For cooling and dehumidifying air, various makes of refrigeration compressors are used, and there are also some systems using lithium chloride equipment for moisture absorption and humidity control.

Air Distribution—Draftless, even air distribution in gage rooms is a problem which has been given a good deal of attention. In one such space, a perforated metal ceiling has recently been installed and is performing satisfactorily. During a test, with incoming air at 68 F and a room temperature of 74 F, the maximum air velocity found anywhere in this room by means of a direct reading air velocity meter was 35 fpm. This method of air distribution is also used in a final assembly room where low humidities are carried to prevent moisture and rust on parts.

Air Recovery—In one of the air conditioned plant departments where large quantities of various solvents were used, it formerly was necessary to employ 100 per cent outside air to protect the workers against the resulting fumes. This worked satisfactorily in spring and fall, but presented a serious problem in winter particularly, as the boiler plant must operate at its maximum capacity to meet plant heating and production steam requirements. Furnishing steam to heat excessive quantities of ventilation air was practically an impossibility with the available boiler capacity. In summer, the large load due to outside air taxed the available refrigerating capacity.

* * *

HPAC's editor recently visited two of the Jack & Heintz plants at Cleveland, where the "Jahco associates" manufacture a number of products which contribute to the air power of the United Nations. The heating and air conditioning problems at these plants are typical of those encountered in industry, and the methods of solving them are of general application. . . . Of interest is the method of cleaning air filter units in the production department's continuous degreaser, coating the filters in the spray painting department, use of air recovery equipment to allow recirculation of air and thus reduce steam requirements in winter and refrigeration requirements in summer, perforated ceiling air distribution in a gage room, and continuous slot ventilation of plating tanks . . . Imbued with the informal atmosphere of the Jahco organization, the writer has made these notes on some of the things seen during his visit quite informal

* * *

The situation was corrected by the installation of air recovery or odor adsorption equipment of the activated carbon type. Air from the department is passed through canisters of activated carbon (at the rate of 15 cfm per canister), which adsorb the solvent fumes, and the air is then recirculated for re-use. By this means, the outdoor air requirements for ventilation have been reduced materially, thus saving steam in winter and refrigeration in summer. The steam saving is doubly important, for the boiler plant must operate at peak load to supply the other plant requirements, as mentioned above.

Oil Mist—In a plant of this kind, there are numerous process ventilation problems which must be solved. For example, some departments where high speed machining is done present the problem of oil mist in the atmosphere, which leads to hazardous working conditions, damage to the building and equipment, and waste of oil. It is planned to install electrostatic air cleaners to precipitate the oil mist out of the air and to recover the oil for re-use.

Plating Tank Ventilation—In the plating departments, continuous slot ventilation of the open top plating tanks is employed. There are slots on each side of the tanks, which tanks are roughly 3 ft wide by 4 ft long, with husky ducts leading from the slots down through the floor and outside. By this means, the room atmosphere is kept clear and healthful. The large quantities of air which must enter the building to make up for air taken out through the slots still present a problem, though, especially in the winter. Much of it is introduced to the building through fan equipped heating coils, but a lot of the air must find its way in through open doors and windows.

Cleaning Air Filters—The plant engineering and production departments cooperate in cleaning air filters at Jahco. Numerous unit air filters of the cleanable type are used, and regular readings of pressure drop across the filter banks are taken by means of pitot tubes and inclined gages. When the pressure drop reading indicates that the filters need cleaning, the filter units are removed and put through the production department's continuous degreaser equipment to remove the dirt and oil. The cleaned filter units are then sent to the spray painting department, and are coated with new oil by means of regular production spray guns. They are then again ready for service.

The air filters are put through the continuous degreaser just before the solution used in the degreaser is to be changed. The first time this filter cleaning scheme was tried, new solution had just been put in the degreaser; the production department wasn't too happy about the large amount of dirt removed from the filters, so for the sake of good inter-departmental relationships, the air filters are run through the degreaser only when the degreaser solution is about due for a change anyhow.

Glass Block Construction—In several of the buildings, large panels of glass block construction have been used, but apparently difficulty with drafts, due to cold air flowing down across these surfaces, has been experienced in winter. In some of the offices, shelves have been constructed along these glass block walls in an attempt to minimize the down-flow of cold air, and finned pipe radiation has been installed a foot or so above floor level along the glass block panels to counteract the flow of cold air.

Sun Screen—Sun screen is used on certain of the glass exposed areas to minimize sun effect. In one of the plant office buildings, and in the pilot assembly in this plant, the sun screen assists in maintaining a uniform temperature in summer without excessive problems of zoning the air conditioning system due to sun heat.

Unit Heaters—The method of heating the plant buildings in general, except for the spaces where complete air conditioning equipment is installed, is by means of vertical projection unit heaters. Air locks heated by unit heaters are provided for loading and unloading trucks in winter, to prevent cold drafts in working areas. Steam for heating is distributed at 8 to 10 psi. The boilers serving the plant I visited which was constructed before the war are oil fired, and those for the plant constructed under wartime restrictions have stokers. The new boiler plant has few instruments, much to the regret of the operating personnel, and has to be operated to get the steam out in the best possible manner with the controls and instruments which are available.

That Smokestack

JUST FOR the record and with no desire to detract from our Seabees' accomplishments, the stack statistics shown on page 335 of the June HPAC should be corrected.

The photograph shows 12 drums make up the stack height. If they are standard 50 gal oil drums they are 3 ft high each, if 100 gal approximately 4 ft, so the stack is somewhere between 36 and 50 ft high. A comparison with the height of the building is a rough check on the 36 ft height.—DONALD G. COOMBS, Army Service Forces.

ILLUSTRATION AT margin of page 335—June issue—36 oil drums—over 160 ft high—tsk, tsk, tsk, tsk. . . . Should your face be red! Or are you stringing us?—K. T. STEARNS.

* * *

HPAC's readers and editors will welcome your comments on articles published in these pages, and on other topics of interest. Address The Editor, Heating, Piping & Air Conditioning, 6 North Michigan Avenue, Chicago 2.

Confer on Possible Changes In Fuel Oils After the War

REFERRING TO the report of the conference on possible changes in fuel oil standards (p. 335, June HPAC), it is understandable that refiners are primarily concerned with marketing problems. The wider the range of specifications, the simpler is the manufacturing and distribution of fuel oil. As against this, the burner manufacturer seeks close limits on oil characteristics, so that he can design a burner to meet a specific set of conditions. It may therefore be that a higher wisdom will have to act as arbitrator to establish limits on the fuel oil grades.

The Bureau of Standards so far has been acting merely as the clearing agency, serving to correlate the several viewpoints and ultimately publishing as "standards" the data most likely to represent average or compromise values. It is probable that more cogent authority will have to be displayed in what is a genuinely complicated situation.

If the Bureau of Standards does not care to undertake the necessary investigational work to determine logical limits on fuel oil grades, then the Bureau of Mines could serve admirably well. The scientific and technical investigations of the Bureau of Mines, in coal especially but also in other fuels, have clearly established that its findings are thoroughly dependable and unbiased.

The Underwriters' Laboratories, Inc., also has a deep interest in the matter. For years it has been testing and listing oil burners as suitable for use with certain fuels. Its general practice is to certify that a particular burner can be used safely with a certain fuel, using the grades established by the Bureau of Standards in its listings. Any broadening in these grades jeopardizes the significance of the Laboratories' certification.

Thus there are at least three viewpoints involved. The refiner seeks to simplify his marketing problem, the burner manufacturer needs concise data for design, and the underwriters strive to reduce fire hazard. To complicate this situation, climatic factors weigh heavily. A difference of 20 F in prevailing minimum temperature means a change of 100 per cent in oil viscosity (viscosity doubles for each temperature drop of 20 to 25 F). It appears to me that the issue can be resolved only by research and investigation, of which there has been but little. And if the refiner, burner manufacturer, and insurance company do not want to depend upon governmental agencies, they can take the initiative by a joint technical program to arrive at the answer.—KALMAN STEINER, member of HPAC's board of consulting and contributing editors.

Design and Control of year 'round comfort Air Conditioning Systems

by William Goodman

PRIMARY AIR SYSTEMS

The basic principles that govern the design and control of year 'round conditioning systems are organized and discussed in the series of articles of which this is the fifth, and which is devoted to the considerations involved in the design of so-called primary air systems. No attempt is made in these articles to show a collection of control and equipment arrangements except insofar as they are needed to illustrate the various points discussed. Instead, the methods of accomplishing certain desired results in air conditioning systems and the broad basic principles that govern the applicability of different types of conditioning systems and controls are presented from a refreshingly new viewpoint. Those who are now designing and will be designing comfort air conditioning systems for postwar installation will find this discussion timely and practical, for no matter what the developments of the future, basic principles will always govern. Mr. Goodman is consulting engineer for the Trane Company, and is also a member of HPAC's board of consulting and contributing editors

THE PRIMARY air system was illustrated and described in the May HPAC, and it was shown that while it is not as flexible as the reheating system discussed last month, it can be used satisfactorily in many types of installations where the sensible heat ratio under maximum load conditions is rather high, and in which the character of the loads in the various zones is about the same as discussed in May. For installations such as offices, apartments, and hotel guest rooms where the sensible heat percentage varies from 100 per cent down to, roughly, about 65 per cent during the summer cooling season, the primary system is more economical to operate than a straight reheating system. On the other hand, for installations where the sensible heat percentage is always low, roughly 70 per cent or less, the straight reheating system is (as will be shown later) more economical to operate than a primary system if the maximum humidity is to be limited under all conditions of sensible load.

Considerations in Designing Primary Air Systems

The reason that a primary air system is limited in its application to installations in which the minimum sensible heat percentage does not fall below roughly 65 per cent during the summer cooling season can be seen by referring to Fig. 5 (p. 281, May HPAC) in conjunction with Fig. 13. There is, of course, a very definite relationship between the location of the ratio line on the psychrometric chart and the sensible heat percentage of the system. Thus, a sensible heat percentage like 90 per cent would be represented by an almost horizontal line like *1-2* of Fig. 5. On the other hand, if the sensible heat is only, say, 65 per cent of the total load, the ratio line would be represented by a steep line like *1-8*. The important thing in primary air systems, however, is to know the ratio of the actual sensible load to the sensible load under maximum conditions. In other words, when the ratio line is like *1-8*, what is the ratio of the sensible heat load to the sensible heat load when the line is like *1-2*? The answer to this question can be found in the chart of Fig. 13, as explained in the caption for this chart. For example, this chart shows that if the design sensible heat ratio is 90 per cent and the minimum ratio line is represented by *1-8* which is 65 per cent then the sensible load for the conditions represented by line *1-8* is 25 per cent of the sensible load for the conditions represented by line *1-2*. In other words, the primary air system whose cycle is illustrated on Fig. 5 will work satisfactorily as long as the sensible heat load never falls below 25 per cent of the maximum sensible heat load for which the system is designed. If the sensible heat load falls lower than this, then either reheating must be provided or the system will go out of control; that is, the dry bulb temperature will be lowered below point *1*.

Location of Minimum Line

The location of the minimum line *1-8* on Fig. 5 is, of course, limited strictly by the location of point *8*. If no reheating is to be provided for the primary air, then it is obvious that point *8* must always lie close to the saturation curve because with dehumidification by refrigeration, the air leaving the dehumidifier will always be nearly saturated. After point *8* is lowered beyond a certain location, large changes in its temperature have only a slight effect on the slope of

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the minimum ratio line *1-8*. Consequently, the location of line *1-8* can be varied only within rather narrow limits. For most installations a sensible heat ratio of approximately 60 or 65 per cent is about the lowest that can be obtained practically. As has previously been shown by means of Fig. 13, most primary air systems have as their lower limit a sensible heat gain of approximately 20 or 25 per cent of the maximum sensible heat gain for which the system is designed.

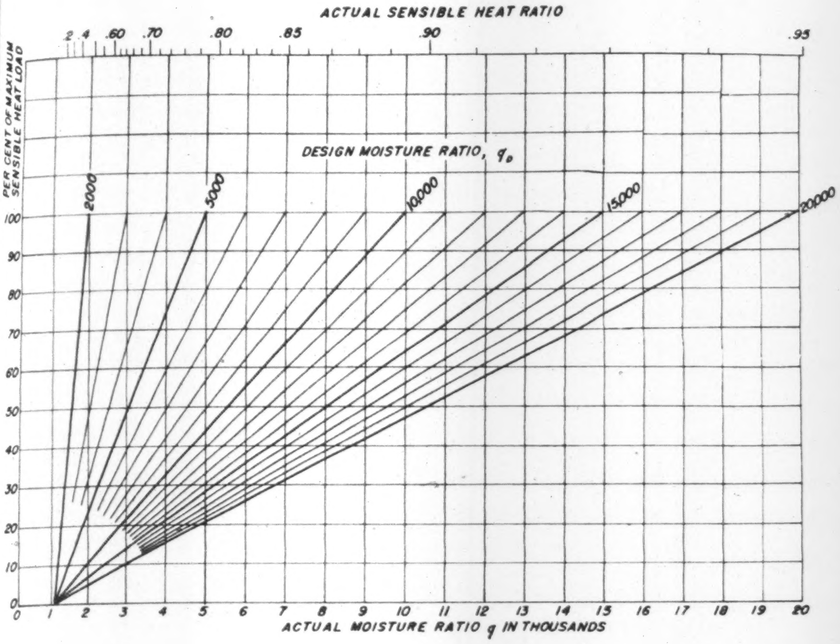

Fig. 13—Chart for determining per cent of maximum sensible heat load as ratio line deviates from the design ratio line. Although the chart is drawn for moisture ratios, it can also be used conveniently if only the sensible heat ratio is known. Thus, suppose the sensible heat ratio at any given time is 0.8. Locate the sensible heat ratio of 0.8 at the top of the chart. Drop down vertically to the bottom and find that the corresponding moisture ratio is 5300. Suppose that the design sensible heat ratio is 0.9. The design moisture ratio of 10,600 is found by dropping down vertically from the 0.9 point at the top of the chart to the scale at the bottom. . . . To find the percentage of the maximum sensible heat load when the actual sensible heat ratio is 0.8 and the design moisture ratio is 0.9, proceed as follows: The moisture ratio corresponding to a sensible heat ratio of 0.9 has been found to be 10,600. Follow the diagonal line for the "Design Moisture Ratio" of 10,600 until it intersects the vertical line of 5300 corresponding to the actual sensible heat ratio of 0.8. At this point read 45 per cent as the "Per Cent of Maximum Sensible Heat Load." This means that at the time the sensible heat ratio is 0.8, the sensible heat load is only 45 per cent of the sensible heat load for which the system has been designed. In other words, when the sensible heat ratio is 0.8, the sensible heat load is 45 per cent of the sensible heat load at the time the sensible heat ratio is 0.9. The moisture load is assumed to be the same at both times. . . . The derivation of the formula on which this chart is drawn is given below*

Pre-mix and After-mix Systems

Before describing methods of determining the quantities of primary and outdoor air, it is necessary to divide primary air systems into two types: the pre-mix system illustrated in Figs. 4 and 5 (pp. 280-281, May HPAC) and the after-mix system of Fig. 14. In the pre-mix system the primary and secondary air are mixed *ahead* of the secondary cooling coil. In the after-mix system the primary and secondary air are mixed *after* the secondary coil. Whether this mixing takes place immediately after the secondary coil or in the conditioned room itself makes no difference insofar as this discussion is concerned. The after-mix system will be described because its computation is a little simpler than the pre-mix system. Exactly the same formulas and principles are used in the computation of the pre-mix system. Once these principles are understood, the reader will have little difficulty in applying them to the pre-mix system.

In any primary air system, the primary air can be a mixture of outdoor air and return air. Usually, however, the primary air is 100 per cent outdoor air in order to provide the air necessary for ventilating purposes. The secondary air can also be a mixture of return and outdoor air. Usually, however, it is all return air. Consequently, in the balance of this article the phrases *secondary air* and *return air* are used interchangeably.

The after-mix primary air system illustrated in Fig. 14 should not be confused with the double duct system of Fig. 10, which was shown on p. 342 of the June HPAC. For a double duct system like that of Fig. 10, each duct must be able to carry almost the entire air supply alone. In the system illustrated in Fig. 14, on the other hand, the primary air duct is small, being sized to carry only the primary air supply, which is roughly about 20 per cent of the total air supplied. Similarly the secondary air duct is sized to carry only the secondary air which would ordinarily be about

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*Derivation of formula from which Fig. 13 was drawn:

$$q = \frac{Q}{W} + h_o \quad \ldots\ldots\ldots\ldots\ldots [a]$$

$$q_D = \frac{Q_D}{W} + h_o \quad \ldots\ldots\ldots\ldots\ldots [b]$$

where Q = actual sensible heat load at any given time; Q_D = design sensible heat load; q = actual moisture ratio at any given time; q_D = design moisture ratio; h_o = enthalpy of vapor added to the air (approximately 1100 Btu for comfort cooling); and W = moisture load in lb (assumed to be constant at all times).

Subtracting [a] from [b],

$$q_D - q = \frac{Q_D}{W}\left(1 - \frac{Q}{Q_D}\right) \ldots\ldots [c]$$

Let

$$\frac{Q}{Q_D} = P \quad \ldots\ldots\ldots\ldots [d]$$

where P = ratio of actual sensible heat load to design sensible heat load.

Also from [b],

$$\frac{Q_D}{W} = q_D - h_o \quad \ldots\ldots\ldots\ldots [e]$$

Substituting [d] and [e] into [c], and clearing,

$$P = \frac{q - h_o}{q_D - h_o} \quad \ldots\ldots\ldots\ldots [f]$$

The chart of Fig. 13 was computed by means of this last equation.

80 per cent of the total air supplied.

When designing a primary air system, the ratio line *1-2* for the maximum load conditions is first located on the psych chart, Fig. 15. Next, in order to control the system through as wide a range of sensible heat loads as possible, it is necessary to locate the minimum ratio line *1-8*. Within limits, the lower point *8* is located on the psychrometric chart, the steeper will be the ratio line *1-8*. However, once point *8* has passed beyond a certain point, rather large movements of point *8* downward will have little effect upon the steepness of ratio line *1-8*. Consequently there is little point in lowering the temperature of the air corresponding to point *8* very much with its consequent undesirable lowering of the temperature of the refrigerant in the evaporator. For most installations, it will be found that a ratio line for a sensible heat percentage of, roughly, 65 per cent is about as low as is practical although in some cases lower percentages may be satisfactory.

As has been pointed out, according to Fig. 13 for a design sensible heat percentage of 90 per cent and a minimum sensible heat percentage of 65 per cent, the system will be controllable from sensible heat loads varying from full load down to 25 per cent of the maximum sensible heat load.

After point *8* has been selected along ratio line *1-8*, the amounts of primary and return air to be circulated can be computed. The computation of these quantities will be discussed later.

The cycle for the after-mix primary air system is illustrated in Fig. 15. Under maximum load conditions, the ratio line is *1-2*. Return air from the room is cooled along a line of constant dew point temperature to point *4* by the secondary coil. Then the return air in the condition represented by point *4* and the primary air in the condition represented by point *8* are mixed, resulting in the mixture represented by point *3* along line *1-2*. Whether this mixture takes place in the duct before the air is supplied to the room or whether the primary and return air are delivered to the room independently and then mixed in the room makes no difference insofar as the air computations are concerned.

If, because of a decreasing sensible load, the ratio line falls to *1-5*, the return air would be cooled only to point *7* by the secondary coil. Return air in the condition represented by point *7* would then be mixed with primary air in the condition represented by point *8*, resulting in a mixture like point *6* on ratio line *1-5*.

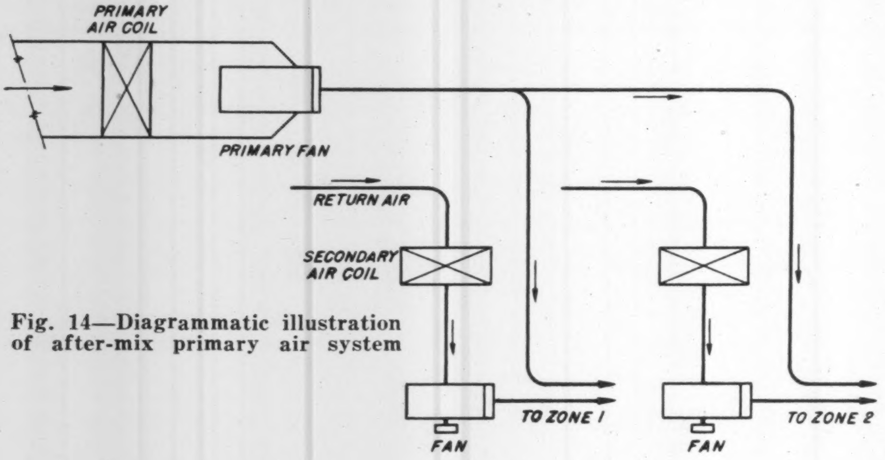


Fig. 14—Diagrammatic illustration of after-mix primary air system

If the sensible heat load in the room fell so that the ratio line of the room was represented by *1-8*, the thermostat would completely cut off the supply of refrigerant to the secondary coil. Return air in the condition represented by point *1* would be mixed with primary air in condition *8*, resulting in a mixture like *9* along ratio line *1-8*.

If the sensible heat load fell lower so that the ratio line was now represented by line *1-10*, the system would go out of control and the dry bulb temperature in the room would drop until a new balance was established.

To maintain control of the dry bulb temperature under the condition represented by ratio line *1-10*, it would be necessary either to reheat the primary air to point *11* or to reheat the air mixture to point *12*. During the in-between weather in spring and fall, if windows cannot be opened and control of room temperatures must be maintained under the action of their thermostats, then reheating of the primary air is essential. If the ratio line for the various rooms swings to the right of minimum ratio line *1-8* of Fig. 15, the dry bulb temperatures in the various zones will drop unless reheated primary air is supplied. In fall and spring reheating is essential in those installations where the need of opening windows is to be eliminated.

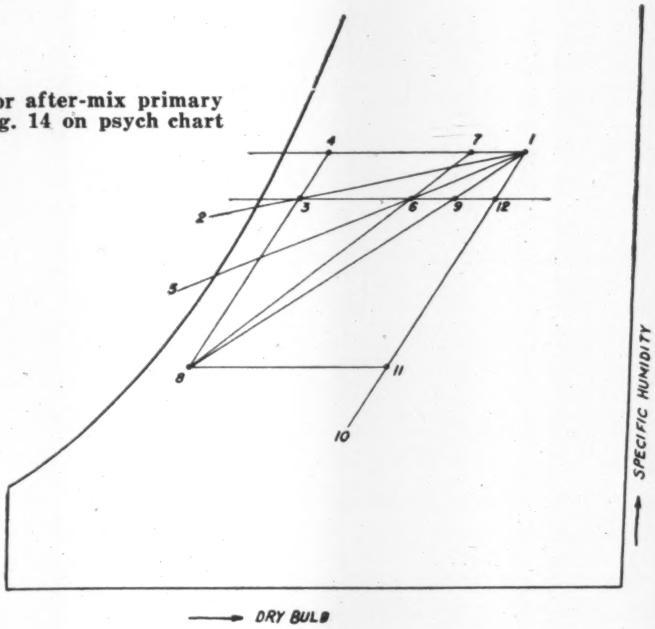
Notice in Fig. 15 that points *3*, *6*, *9*, and *12* are all located on the same horizontal line of constant dew point temperature. As long as the volume of primary air is a constant percentage of the total air supplied, the vertical distance between line *1-4* and line *3-12* is a constant percentage of the vertical distance between line *1-4* and line *8-11*.

Quantities of Primary and Secondary Air

The quantities of primary and return air to be circulated can be computed quite simply. In most air conditioning practice today, it is customary to compute the latent heat gain directly in terms of Btu. However, the latent heat gain in comfort air conditioning can be converted directly into moisture gain in pounds by dividing the latent load by 1040 Btu. After this has been done, the weight of primary air required can be computed by means of the following formula because in a primary air system, the primary air should be capable of absorbing the full moisture gain:

$$W = G_p \ (w_1 - w_2) \quad \ldots\ldots.[2]$$

where W = moisture gain in the conditioned space, lb per hr; G_p = weight of primary air required, lb per hr; w_1 = moisture content of room air, lb per lb of dry air; and w_2 = weight of moisture in primary air supply, lb per lb of dry air.



ig. 15—Cycle for after-mix primary r system of Fig. 14 on psych chart

The moisture content w_2 of the imary air supply corresponds, of urse, to the dew point tempera- re at point *8* of Fig. 15.

The total quantity of air to be livered to the conditioned space n be determined from the differ- ce in the heat content of the air state *1* and the air in state *3* Fig. 15, inasmuch as the total at gain of the room must be ab- rbed by the total air supplied in e state represented by point *3*. nsequently the following formula n be used for determining the total quantity of air for both premix and after-mix systems:

$$H = G(h_1 - h_2) \text{ ....[3]}$$

where H = total heat gain of the room= sum of sensible and latent gains, Btu per hr; G = total weight of air to be circulated, lb per hr; h_1 = heating constant of room air in state *1*, Btu per lb of dry air; and h_2 = enthalpy of mixture supplied to room, Btu per lb of dry air.

In Fig. 15 the enthalpy h_2 of the air supplied is, of course, the enthalpy of the air at point *3* on ratio line *1-2*.

After the total and primary air quantities have been determined by means of the formulas, the amount of secondary air to be passed through the secondary air coil can be determined by subtracting the primary air quantity from the total air quantity. Generally, all of the primary air is taken from the outdoors. However, if the amount of primary air required is greater than the amount that it is desirable to supply for ventilation purposes, then the primary air can be made up partly of outdoor air for ventilation purposes and the balance of return air from the conditioned space. On the other hand, if the primary air required is less than the quantity of air needed for ventilation purposes, then it may be necessary to raise the minimum ratio line *1-8*, thus increasing the quantity of primary air required.

This expedient is undesirable because it decreases the control range of the system. However, if the control range is only slightly decreased, this expedient is generally the simplest and least expensive method of obtaining the required quantity of outdoor air for ventilating purposes. Where the quantity of ventilating air cannot be supplied without seriously impairing the control range of the system, reheating will be required.

COMPARATIVE ENGINEERING DATA ON REFRIGERANTS GIVEN IN NEW TABLES

HE TABLE given below supple- ents the four other tables of data r the refrigerant "Freon-22" hich were published on pp. 337 and 338 of the June issue of HPAC. The text matter with the June tables should be referred to when using this month's table. Future issues will contain similar data for a number of other "Freon" refrigerants, ammonia, methyl chloride, and water vapor.

"Freon-22"—Theoretical horsepower per cu ft of vapor compressed per min

vap emp	Condensing temperature 60	65	70	75	80	85	90	95	100	105	110	115
-20	0.188	0.199	0.210	0.220	0.230	0.240	0.250	0.260	0.270	0.279	0.289	0.298
-15	.194	.206	.217	.229	.240	.251	.262	.273	.284	.294	.305	.315
-10	.198	.211	.224	.237	.249	.261	.273	.285	.297	.309	.320	.331
- 5	.201	.216	.230	.244	.257	.271	.284	.297	.310	.322	.335	.347
0	0.203	0.218	0.234	0.249	0.264	0.278	0.293	0.307	0.322	0.335	0.349	0.362
5	.203	.220	.236	.253	.269	.285	.301	.317	.332	.347	.362	.377
10	.198	.216	.235	.253	.270	.288	.305	.322	.338	.355	.371	.387
20	.186	.208	.230	.251	.272	.292	.313	.333	.352	.372	.392	.410
30	.162	.188	.214	.239	.264	.288	.312	.336	.358	.382	.405	.427
40	0.123	0.154	0.184	0.214	0.243	0.271	0.299	0.328	0.354	0.381	0.408	0.435
50	.0699	.105	.140	.175	.210	.242	.275	.308	.339	.370	.402	.434
60		.0387	.0794	.121	.161	.199	.237	.275	.311	.348	.384	.420

MIST AND DUST COLLECTION

C. E. Lapple Reviews Its Purpose and Summarizes Characteristics

MIST AND dust have always been both a boon and a scourge to mankind. They play a vital role in most natural processes such as rain, fog, snow, and plant fertilization and growth. The universality of dust was well summarized by E. R. Knowles (*9*)* in the Transactions of the ASHVE: "Dust is all pervasive, everywhere, on land or sea; it dwells in the mist, the dew, the rain, the snow; in the calm, the breeze, the storm; in the air we breathe, in the food we eat; in the country, in the city, in our highways and streets; in our mines, our habitations, our factories; in all manufacturing processes; in the smoke from our furnaces." Every cubic foot of "clean" country air contains on the order of 1,000,000 particles of dust larger than 0.1 micron in diameter and a countless number of smaller particles. The dust fall in metropolitan areas is on the order of 1000 tons per square mile per year.

Due to the increasing interest on the part of civic associations in smoke abatement in metropolitan areas as a result of rapidly mounting industrialization of such areas, the increased emphasis on healthful and sanitary working conditions, the increased interest in air conditioning both for the office and the home, the increased utilization in industrial production of processes involving particulate systems (such as spray drying, "fluid catalysts," and vapor phase reactions), and the more competitive nature of industry in which more efficient operation as a result of reduction of losses may be an important item in the margin of profit, the problem of dust and mist control and collection is constantly receiving more attention and prominence (*1, 3, 4, 5, 9*).

The purpose of industrial dust and mist control may be classified into one or more of the following general categories. The examples in each category are by no means complete and are given only as typical cases:

Nuisance elimination: The filtration of office ventilation air would fall into this category, as would ventilation systems for purposes of general plant cleanliness. Other examples include those involving the collection of fly ash from power plant combustion gases and the removal of acid mist from sulfuric acid system effluent gases to avoid a nuisance in the surrounding countryside. Local smoke abatement and health statutes may play an important role in determining the need for dust collection equipment in such cases. What would not be considered a nuisance in one locality may be a serious offense in another.

Improvement of product quality: In certain operations where a product is exposed to gas streams, contaminants entering as a gas dispersoid can have a very detrimental effect on product quality. This is a particularly vital factor in the manufacture of photographic film, rayon, pharmaceuticals, nylon, etc., and the contaminants must be removed from the gas stream before contact with the product takes place.

Reduction of equipment maintenance: Siliceous dust entering the air intake of an internal combustion engine or compressor can raise havoc with the piston rings and cylinder lining. Another example lies in the need to minimize or eliminate dust from pyrites roasting furnace gases prior to their passage into the chamber acid system where dust would plug the Glover towers and scrubbers as well as contaminate the "make" acid. It may also be necessary to remove dust or acid mist from process gases to avoid excessive fouling or corrosion of subsequent heat exchanger equipment.

Elimination of a safety or health hazard: Many dusts, particularly siliceous and certain metallic dusts such as may arise around grinding or drilling equipment and in some metallurgical operations, may be detrimental to health and must be controlled. Other dusts, particularly those of organic nature such as flour, may be explosive if allowed to exceed specific concentrations. In the period 1860-1942, dust explosions took a toll of over 500 killed, over 1200 injured, and over $55,000,000 in property and equip-ent, according to an NFPA pub-cation, National Fire Codes for he Prevention of Dust Explo-ions (*12*). Over half of these ex-losions occurred in the last 20 ears of this period and averaged ver $70,000 property damage for ach explosion.

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*Numbers in parentheses refer to bibliography at end of article.

Recovery of a valuable product: Large savings may often be ealized by recovery of dust from ryer gases and in some cases from entilation gases. Dumping booths ffer a common example of the lat-er. Smelter fumes, particularly in he case of copper, silver, mercury, rsenic, and tin, may represent tre-endous values.

Collection of powdered products: This category may well have been ncluded in the previous one but is nique in that the entire plant out-ut is in the form of a dust at one tage or another. Outstanding in his group are the manufacture of igh purity zinc oxide, carbon lack, and spray dried products uch as powdered milk, eggs, and oap. Pneumatic conveying is an-ther operation falling into this lass.

As a prerequisite to the design f industrial control equipment, it s necessary to recognize and un-erstand the fundamental proper-ies and characteristics of gas dis-ersoids.

Particle size: The primary dis-inguishing feature of gas disper-oids is particle size. The most widely used unit of particle size is the micron, which is defined as 1/1000 of a millimeter and is equal to 1/25400 of an inch. It is usually designated by the symbol μ. This symbol should not be confused with the symbol μ for viscosity or with the symbol $m\mu$ (millimicron) which is often used to designate 1/1000 of a micron. The particle size of a gas dispersoid in the United States is usually taken as the average or equivalent diameter of the particle, though some writers (particularly German) specify particle size as the radius, often tacitly.

Another common method of specifying particle size is by means of mesh size. Screen mesh is defined as the number of screen openings per linear inch. The particle size specified in terms of mesh then means that the particle diameter is equal to the aperture of the screen of the corresponding mesh. The aperture of a screen of specific mesh will in turn depend on the wire diameter used in manufacturing the screen. Two standard series of screens are in common use in the United States. The aperture and wire diameter of the screens in these series are given in Table 1. The 200 mesh screen, with an aperture of 0.0029 in. and a wire diameter of 0.0021 in., has been adopted as the standard for both screen scales. In the Tyler scale, the aperture of each successive screen differs from that preceding it by the ratio

$$\sqrt[4]{2}$$

and the screen number represents the actual meshes per linear inch. In the U. S. screen scale the mesh designation is only a rounded off value of the actual meshes per linear inch. A third screen scale, I.M.M., is also in use in the United States, while in Europe the common screen scales are the British Standard fine mesh (B.S.S.) and the German Standard (D.I.N.) (*10, 20*). It is apparent that the use of a mesh designation for particle size may lead to considerable confusion unless care is taken to specify the screen scale standard. Consequently particle size is preferably stated in terms of microns or inches.

"Dust is all pervasive, everywhere, on land or sea . . . in all manufacturing processes; in the smoke from our furnaces". The problem of dust and mist control and collection is constantly receiving more attention and prominence, in order to eliminate nuisances, guard health and safety, reduce maintenance of equipment, recover valuable products, etc. . . . Mr. Lapple, of the technical division, engineering department, E. I. du Pont de Nemours & Co., reviews the purpose of mist and dust control and collection in this article (first of a group comprising a comprehensive treatment of the subject), and discusses the characteristics of mists and dusts. A listing of references is appended

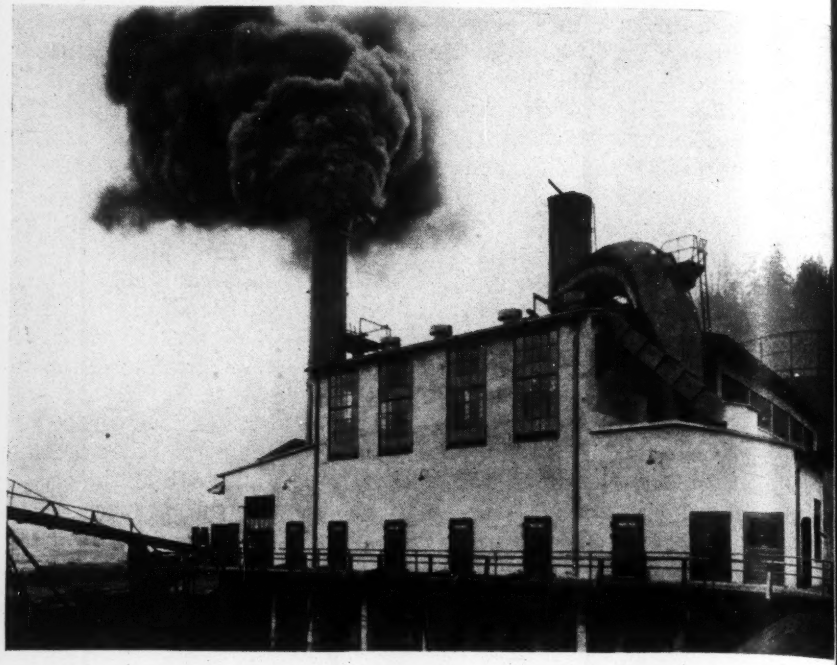
Practical considerations make it infeasible to construct screens finer than 400 mesh. However, subsieve sizes are sometimes expressed in terms of a "theoretical" screen mesh. The micron sizes corresponding to these theoretical screen sizes are given in Table 2.

Particle classification: There exists considerable confusion regarding the terminology of gas dispersoids. Gas dispersoids are generally classified according to their method of formation and particle size. Gas dispersoids may be classified into two general categories, "mechanical dispersoids" and "condensed dispersoids," according to E. Anderson, in a paper published in 1924 by the American Institute of Chemical Engineers (*1*). Mechanical dispersoids are formed by comminution, decrepitation, or disintegration of larger masses of material, as by grinding of solids or spraying of liquids. Mechanical dispersoids may be classified further as "dust" or "spray," the former applying to solids and the latter to liquids. Condensed dispersoids are formed by condensation of the vapor phase or as the product of a vapor phase reaction. Solid and liquid particles formed in this manner are termed "fume" and "mist," respectively. Each of these methods of formation results in particles of a certain size range as indicated in Table 3. The demarcation between mechanical and condensed dispersoids on a particle size basis is not as sharp as indicated in this table; some dusts may be as fine as 0.1 micron and some mists may be as large as 20 microns. The particle size values given in the table are merely representative particle size interpretations of the most probable case.

"Smoke" is a term that usually applies to a fume or mist formed by combustion. "Fog" generally applies to a mist larger than 1 micron in diameter, while "rain" generally refers to a spray larger than 100 microns in diameter. Both these terms are usually used in connection with natural phenomena but are sometimes applied to similar process particles.

Condensed dispersoids generally tend to flocculate or agglomerate to form particles of larger size and may actually form particles that are larger than some mechanical dispersoids. A common example is the agglomeration of fog particles to form rain. This illustrates the difficulty of classifying gas dispersoids into definite particle size groups. It should be pointed out that the above definitions of terms are based on the author's impression of most prevalent and precise usage and many writers use these terms otherwise. For example, "mist" is often referred to as "fume." The above definitions will be adhered to in these articles where the distinction is important, otherwise the term "mist" will be used to indicate any liquid dispersoid and the term "dust" to indicate any solid dispersoid for purposes of conciseness and simplicity.

In order to give the reader a further physical conception of particle size, Tables 4 and 5 have been prepared. Table 4 gives the approximate particle sizes of some common dusts. Natural and process dusts are generally produced in a wide particle size range and vary a great deal with the specific conditions involved in their formation. The particle size of fumes depends to a large extent on their age due to their flocculating tendency. Consequently, the values given in Table 4 should be regarded only as average, "order of magnitude" quantities, and wide variations from these values are possible. The values of Table 5 are presented to relate particle size to some common physical properties.



Explosion hazards: Most mists and dusts that are capable of uniting with oxygen or reacting in any other way to form a gaseous product are a potential explosion hazard. In order to ignite the mist or dust, it is necessary to raise the temperature at some point above the combustion or reaction temperature, usually by means of a flame or spark. The explosion is the result of a sudden volume expansion due to the large volumes of combustion or reaction gases formed, together with the large heats of reaction that are liberated. With coarse particles, the surface exposed to reaction is relatively small and the conduction of heat through a particle is so slow that it is difficult to start ignition or to propagate a reaction that may have started at some local point. For fine particles these two hindrances to ignition tend to become small so that fine combustible particles suspended in air tend to behave like inflammable mixtures of gas and air. To illustrate the difference between coarse and fine particles, consider a spherical 10 mesh (0.065 in. diameter) particle which has a total surface area of 0.0133 sq in. If this particle were subdivided into 10 micron diameter particles, there would be formed 4,500,000 particles with a total surface of 2.2 sq in.

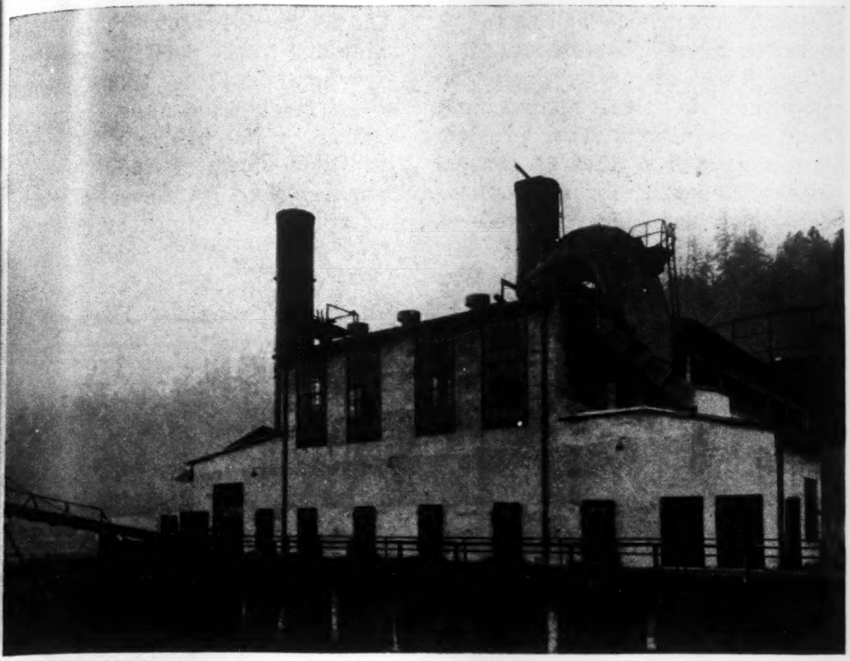
Table 1—Standard Tyler and U. S. Screen Scales

Tyler Screen Scale Mesh Number	Nominal Aperture Width Inches	Nominal Aperture Width Microns	Wire Diameter Inches	U. S. Screen Scale Mesh Number	Nominal Aperture Width Inches	Nominal Aperture Width Microns	Wire Diameter Inches
400	0.0015	37	0.0010	400	0.0015	37	0.0010
325	0.0017	43	0.0014	325	0.0017	44	0.0014
270	0.0021	53	0.0016	270	0.0021	53	0.0016
250	0.0024	61	0.0016	230	0.0024	62	0.0018
200	0.0029	74	0.0021	200	0.0029	74	0.0021
170	0.0035	88	0.0024	170	0.0035	88	0.0025
150	0.0041	104	0.0026	140	0.0041	105	0.0029
115	0.0049	124	0.0038	120	0.0049	125	0.0034
100	0.0058	147	0.0042	100	0.0059	149	0.0040
80	0.0069	175	0.0056	80	0.0070	177	0.0047
65	0.0082	208	0.0072	70	0.0083	210	0.0055
60	0.0097	246	0.0070	60	0.0098	250	0.0064
48	0.0116	295	0.0092	50	0.0117	297	0.0074
42	0.0138	351	0.0100	45	0.0138	350	0.0087
35	0.0164	417	0.0122	40	0.0165	420	0.0098
32	0.0195	495	0.0118	35	0.0197	500	0.0114
28	0.0232	589	0.0125	30	0.0232	590	0.0130
24	0.0276	701	0.0141	25	0.0280	710	0.0146
20	0.0328	833	0.0172	20	0.0331	840	0.0165
16	0.0390	991	0.0235	18	0.0394	1,000	0.0189
14	0.046	1,168	0.025	16	0.0469	1,190	0.0213
12	0.055	1,397	0.028	14	0.0555	1,410	0.0240
10	0.065	1,651	0.035	12	0.0661	1,680	0.0272
9	0.078	1,981	0.033	10	0.0787	2,000	0.0299
8	0.093	2,362	0.032	8	0.0937	2,380	0.0331
7	0.110	2,794	0.0328	7	0.111	2,830	0.036
6	0.131	3,327	0.036	6	0.132	3,360	0.040
5	0.156	3,962	0.044	5	0.157	4,000	0.044
4	0.185	4,699	0.065	4	0.187	4,760	0.050

Table 2—Theoretical Screen Mesh Scale

Theoretical Screen Mesh	Equivalent Particle Diameter Microns
625	20
1,250	10
2,500	5
5,000	2.5
10,000	1.25

Once local ignition has taken place, it will tend to propagate to particles in the surrounding area. It is this rate of propagation that determines the violence of the primary explosion. The rate of propagation depends on the dust concentration, the particle surface (or particle size), and the chemical



The purpose of industrial dust or mist control may be to eliminate a nuisance, reduce equipment maintenance, eliminate a health or safety hazard, recover a valuable product, collect powdered products, etc. At this briquetting plant of a gas company, a lampblack sludge, obtained from cracked California petroleum used for domestic gas and containing approximately 40 per cent water and an appreciable quantity of tar, is dried in rotary dryers. An electrical precipitator handling a gas volume of 63,500 cfm at 151 F is employed to remove tarry constituents from the effluent dryer gases. The view at the right shows the gas effluent from the stack with the precipitator in operation, and the view at the left shows the same plant in operation with the electrical current to the precipitator shut off (photos courtesy Western Precipitation Corp.)

composition of the particle. Dusts larger than 35 Tyler mesh are not usually considered explosive unless they are chemically unstable, such as metallic acetylides. Dust concentrations below 10 grains per cu ft are usually not considered explosive or inflammable (see p. 192 of reference *3*). Upper limits of explosive dust concentrations probably also exist, but few reliable data are available.

Explosions usually take place in two stages—a light primary explosion followed by a possible devastating secondary explosion. The primary explosion is the result of ignition of dust in suspension. This is usually light since the total mass of dust in suspension in a given system of ductwork or equipment is not very great. The primary explosion, however, can raise large quantities of dust that has settled out in ductwork or that is stored in nearby equipment or storage bins. It is the ignition of this raised dust that constitutes the disastrous secondary explosion. It is for this reason that cleanliness and avoidance of dust accumulations are stressed in plants where dust explosions are a possibility. Dust storage bins should also be so situated that a primary explosion in other equipment cannot affect them.

Table 3—Classification and Particle Size Range of Gas Dispersoids

Classification	Approximate Particle Diameter Microns
Mechanical Dispersoid	
Dust	Greater than 1
Spray	Greater than 10
Condensed Dispersoid	
Fume	Less than 1
Mist	Less than 10

Explosions may be set off in any of the following ways:

Open flame—Open flames such as from kerosene lamps, matches, cigarettes, gas burners should not be permitted in locations where explosive dusts are present.

Friction sparks—Sparks may result from the striking of ferrous metals. Nonsparking tools should be used in dust laden areas, tramp metal should be kept out of ventilation or conveying systems, and bronze or similar nonsparking materials should be used for moving parts, such as fan wheels.

Table 4—Approximate Particle Sizes of Some Common Dusts

Dust	Approximate Particle Diameter Microns
Alkali fume	1-5
Ammonium chloride fume	0.1-1
Atmospheric dust	0.5
Atmospheric fog	2-15
Cement dust	40
Coal dust	5-10
Condensed zinc dust	2
Flour mill dust	15
Pigments	0.2-2
Smelter dust	0.1-100
Silica dust	1-10
Sprayed zinc dust	15
Sulfuric acid mist	1-15
Tobacco smoke	0.2
Talc	10
Zinc oxide fume	0.05

Static electricity—Friction between dissimilar substances may result in an electrical potential. The electrical discharge from such a potential can set off a dust explosion. Gases flowing at high velocity may produce a charge on the enclosing duct or pipe. Conveyor belts or metal spouts may also accumulate a static charge. Particles moving in an air stream will usually accumulate a charge. Static electricity can be minimized or avoided by proper grounding of all moving or metallic parts. Bag collectors are sometimes grounded by means of copper braids sewn along the bags. Maintaining a relative humidity of over 60 per cent will usually avoid the accumulation of a static charge.

Faulty electrical equipment.

Heat—Heat generated by overheated bearings or belt friction may start an explosion. Ball or roller bearings are usually recommended for such service.

Spontaneous ignition—Spontaneous ignition is usually the result of a slow oxidation in stagnant material. This will not cause an explosion, but the resulting flame may set off a dust explosion.

Quite often an inert atmosphere is resorted to in order to avoid a dust explosion. Oxygen concentrations below 8 per cent will usually not support combustion, according to the NFPA publication, National Fire Codes for the Prevention of Dust Explosions (*12*). In any case where a dust explosion hazard exists, precautions should be taken to safeguard life and property in the event of an explosion.

Health hazards: Disability from exposure to dust can be classified

Table 5—Approximate Dimensions of Some Common Items

Item	Dimension Microns
Limit of visibility with naked eye:	
Absolute limit	10
Probable limit	40
Diameter of large molecules	0.005
Wave length of visible spectrum:	
Violet light	0.4
Red light	0.7
Wave length of x rays	0.01-0.001
Diameter of human hair	50-200

as the pneumoconioses (such as silicosis and asbestosis) which are caused only by dust inhalation, and toxic effects, which are caused by breathing, swallowing, or absorption through the skin or tissues. The latter group can be divided into several subgroups: toxic effects resulting in general symptoms, which are caused by such dusts as lead, mercury, arsenic, or cadmium; metal fume fever, a temporary malady resulting from inhaling certain metallic oxides such as zinc oxide, copper oxide, and magnesium oxide; allergic reactions, resulting from personal susceptibility to exposure to certain chemicals which may cause dermatitis or "skin rash" or from inhalation of pollen or other organic dusts which may cause hay fever or asthma; irritant action, such as sneezing, coughing, congestion, eye irritation, or vomiting. Those dusts causing irritant action must be considered as potentially toxic when exposures are of long duration or to large concentrations. It is claimed in the case of dermatitis that once a person has become exposed or sensitized to a specific material, he becomes more sensitive to repeated exposure as well as to exposure to other substances (*13*).

Health hazards are of particular importance in plant management from the legal and labor problem aspects as well as that of general plant efficiency. Probably no phase of the problem has received as much attention as that of silicosis. It has been estimated that over 500,000 men are directly exposed to harmful amounts of silica dust (*14*). The hazard is present in foundries from abrasive blasting and grinding equipment, in mining and quarrying operations, in smelting and refining operations, in stone cutting, in potteries, in glassworks, etc.

Silicosis is believed to be due to the action of free silica which, when inhaled, accumulates in the lungs and causes the formation of fibrous nodules which interfere with the normal respiratory process. Silicosis is often complicated by pulmonary tuberculosis and has no known cure. The total damage due to inhaling free silica dust is believed to be due to the total mass that reaches the lungs (see p. 59, reference *4*). Particle sizes of 0.5 to 5.0 microns are considered as the most dangerous. This is probably due to the fact that relatively few particles larger than 5 microns ever reach the lungs, being removed by impingement in the respiratory tract, while particles smaller than 0.5 microns are not as apt to be retained by the lungs. The finer particles, however, cause lung damage at a faster rate than the coarser particles. Data are still too meager and conflicting to permit any final conclusions regarding the effect of particle size. References *2, 4, 13, 14, 18, 19* contain further information on dust health hazards.

Miscellaneous properties: For many processes in which dusts are handled the bulk density, porosity, and pouring properties are of importance—for example, in packaging powders, in unloading storage bins by means of hoppers, in transporting dusts by means of screw or bucket conveyors, and in catalyst or filter beds (*3, 6*). The settling velocity of mists and dusts constitutes the most important property from the viewpoint of design of mist and dust collection equipment.

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STEAM PRESSURE REDUCING VALVES

John J. Woolfenden Discusses Reducing Valve Capacity, Selection, Installation

"A mechanical device like a steam pressure reducing valve can be a valuable aid or a constant source of trouble, depending upon the degree of appreciation of its characteristics possessed by the user." Mr. Woolfenden—of the engineering staff of Smith, Hinchman & Grylls, Inc., architects and engineers—described the types of steam pressure reducing valves, the fundamentals of their construction and operation, and gave comments on selection of the right valve size in his article in the June HPAC. This month, he discusses valve capacity and makes installation suggestions

Let us consider the basis upon which the capacity of a reducing valve is determined. First, there is the throttling effect of the orifice. Second, there is the pressure drop through the steam passages of the valve itself. The former depends, of course, upon the lift of the valve and the size of the valve opening in the seat, and the latter upon the steam velocities through the valve.

If the valve, for example, is required to reduce the pressure from, say, 100 psi to 50 psi, a loss of 10 psi or more in passing through the valve will be negligible. Should the pressure reduction however be from, say, 100 psi to 90 psi, very little pressure drop can be tolerated.

In stationary practice, steam velocities of 6000 to 7000 fpm are considered normal, although in power plant and central station work, velocities of 10,000 fpm or more are not unknown. It is in marine practice, however, where space is at a premium, that high velocities are common, 14,000 or 15,000 fpm often being considered as not excessive.

The higher the velocity (within reason) the better, as a high velocity insures that the valve will be open and not partially closed.

It must be borne in mind, however, that a reducing valve is somewhat noisy at the best, and when the steam is passing through it at high velocity it is quite likely to make itself heard. While such a condition might not be objectionable in a power plant, it certainly would not do in a school building. Consequently, judgment should be used when considering velocity through the valve.

As an example of what this really means, I recall one instance where the reducing valve specified was 6 in. x 8 in. As I remember the conditions, the pressure reduction was 50:10 psi. I was, at that time, representing a manufacturer of pressure reducing valves and with the engineer's consent offered for the required service a 3 in. straightway valve, backed by the manufacturer's guarantee that it would pass all the steam required by the specified load. The valve specified was quoted at about $230; the 3 in. valve, which was a much finer piece of mechanism, was offered at $205 and was worth it. In addition to its intrinsic features, it would have a much longer life and lower maintenance cost. Under the specified load conditions it would not be excessively noisy, as reducing valves go. Since the operation required was continuous during the heating season, the chances were, that had the larger valve been installed, it would have been so seriously cut within a few months that the seat, at least, would have required replacement well before the end of the first heating season.

To put it on the capacity basis, the capacity of a 3 in. valve, under the stated conditions, would be in the neighborhood of 15,000 lb per hr, maximum, while a 6 in. valve would be capable of passing some 85,000 lb per hr. These figures must be considered as approximate only as the exact quantities depend upon the design of the valve and might vary appreciably from those given.

In brief, then, there must be a "balancing" of the probable life of the valve against the noise (or the velocity which causes it) and a decision reached, giving due weight to whichever of the factors is most important under the conditions of service.

We sometimes hear it suggested that, in the case of a high ratio of reduction (i.e., a great difference between the high and the reduced pressure), it may be desirable to take some of the pressure drop in the supply pipe to the valve; in other words, to use such a velocity in the supply pipe that the friction drop will reduce the required amount of pressure reduction by the valve itself. When such a procedure is under consideration, it must be borne in mind that the less the pressure reduction the larger the reducing valve. In other words, the reducing valve which will pass, say 60,000 lb of steam per hr when reducing from 100 psi to 50 psi will pass something like 25,000 lb per hr when reducing from 75 psi to 50 psi.

If, then, the reduction is to be effected by means of a single valve (i.e., in one stage), the only economy effected will be by whatever saving may result from the reduction of the supply pipe size, which will probably not be much and which may even be entirely offset by the increase in cost of the larger valve.

On the other hand, if two stage reduction is otherwise required, increasing the pressure drop in the supply pipe may result in the elimination of the requirement for the second valve. In this connection, it must be borne in mind that, first, the amount of pressure drop obtainable by increasing the velocity of steam in the supply pipe is limited by other considerations and,

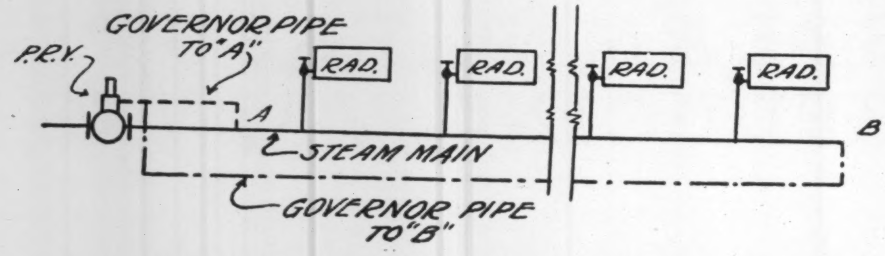

Fig. 1—Heating system supplied with low pressure steam through a reducing valve. Bypass around the reducing valve, return piping, etc., are not shown in this simplified sketch

second, that under lighter loads, the pressure drop will decrease since, for example, if the load be reduced by 30 per cent, the friction drop will (theoretically) be reduced to about half its value at full load.

The natural question is, "When is two stage reduction required and why is it necessary?" To answer this, let us consider an extreme case: Required, 50,000 lb of steam per hr, with a reduction of from 150 psi to 5 psi.

Could the conditions be satisfactorily met by use of a single valve, a 5 in. size would be required, as the required capacity exceeds that of a 4 in. valve.*

Dividing the reduction into two approximately equal stages, 150 to 80 and 80 to 5, we find that each stage will require a 5 in. valve.

Again, if we reduce from 150 psi to 100 psi and 100 psi to 5 psi, two 5 in. valves will be required. As a matter of fact, with 150 psi initial pressure, this is about the best that can be done, regardless of the arrangement used since, if one step is made sufficiently great to utilize a 4 in. valve, the other step will require at least a 6 in. size.

Why, then, should we use two 5 in. valves in place of one valve? Simply because, with such a great difference in pressures, satisfactory control might be difficult to attain and, since the governing is from the low pressure side, and the pressures are "balanced", the discrepancy in areas would be great and the sizes of the areas subject to the reduced pressure would be too large for practical purposes since large diaphragms are weaker than small ones, for any given thickness, and to increase the thickness to compensate for this would decrease the flexibility.

The exact line of demarcation between one and two stage reduction is rather difficult to define, as it is somewhat indefinite and depends to a considerable extent upon the type of valve. When the difference between the initial and the reduced pressures exceeds, say, 70 or 75 psi it is well to weigh the considerations carefully and, generally speaking, if the differential exceeds 100 psi, two stage operation is strongly indicated with many types of valves (although not all).

There are several points which should be considered in connection with the installation of reducing valves, the most essential of which are mentioned below.

Provide Relief Valve on Reduced Pressure Side

It is most desirable that a relief valve be provided on the reduced pressure side of each pressure reducing valve and it is essential that such a relief be provided should the initial pressure be in excess of the safe working pressure of the low pressure system or any part thereof.

This may seem questionable, as the reducing valve is arranged to so govern the reduced pressure that it cannot exceed the predetermined value for which the valve is adjusted. It is to be borne in mind, however, that automatic apparatus is dependable just as long as it works properly and no longer and there is usually no external indication of the fact that such apparatus is about to "run amok." A leaky reducing valve will permit the building up of the pressure on the low pressure side and eroded single seated valves will leak when in the closed position, just as well as any double seated valve in good condition; furthermore, under certain conditions, any reducing valve may "pop wide open" and stick in that position.

I know of one case where, when the steam was suddenly admitted to the supply pipe to a large reducing valve, the valve popped open and stuck. The water in the gage glasses of a battery of large boilers instantly went out of sight—how far down it went, nobody knows; as a matter of fact, nobody tried to find out. Fortunately, that was all that happened.

It is best that the discharge from such relief valves be kept inside the building, as slight puffs of vapor are given off from time to time and the freezing of these has been known to effectively plug the end of the vent pipe. If likely to be objectionable, the discharge can be piped to some suitable location inside the building, or two relief valves can be used, one discharging inside and one outside the building, the former being set to relieve at a slightly higher pressure than the latter so that unless that discharging outside failed to function, the one discharging inside would be inactive.

It is desirable to have suitable pressure gages on both the high and the low pressure piping at each reducing valve.

A bypass, preferably of the well known three valve arrangement, should be provided around each re-

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*The figures used in this illustration, although correct for certain types of valves, will not necessarily apply in general and must therefore be considered as illustrative only.

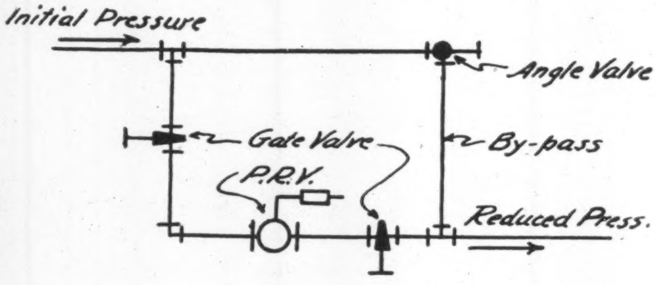

Fig. 2—Schematic diagram showing a simple arrangement of a three valve bypass for a pressure reducing station. The gages, etc., are not shown. Arrows show direction of steam flow

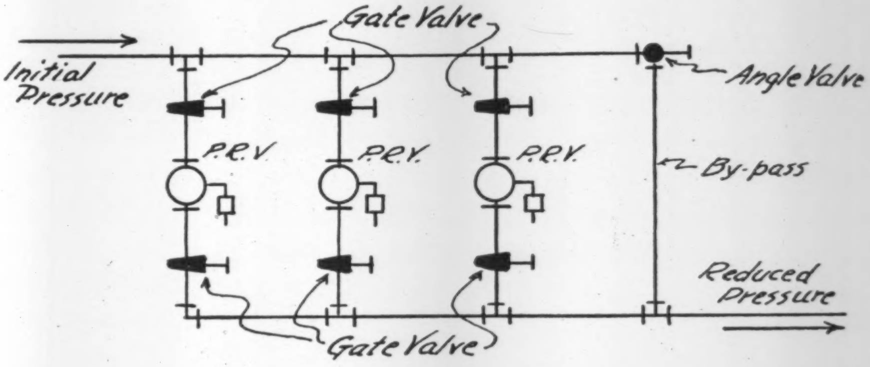

Fig. 3—Arrangement of a multiple pressure reducing valve station with a single bypass. Gages, etc., not included. Arrows indicate steam flow.

ducing valve or group of reducing valves so that, in case of removal or shutoff of the valve for repairs, etc., steam can still be admitted to the low pressure system and the pressure controlled by manual throttling, for temporary service. This bypass is often made considerably smaller than the supply pipe to the valve, if the pressure reduction is great.

Bypass Around Reducing Valves

A quite common, although arbitrary, rule is to make the area of the bypass about one-half of that of the supply pipe to the valve it serves. Like all other arbitrary rules, however, it must be applied with judgment, especially in the case of very small valves. In any event, the pressure reduction—not arbitrary rules—should be the determining factor.

In the case of a group of valves in parallel, one bypass may serve the group, provided that the difference in capacity between the smallest and the largest valves is not too great.

Another matter to be considered is the governing of the valve. My article in the June HPAC mentioned "internal governing", and pointed out its limitations due to the fact that the reduced pressure inside the valve body may not be stabilized and turbulence and eddies are likely to be present to a greater or less extent.

Some authorities recommend connecting the governor pipe to the low pressure steam main at least 15 ft away from the valve. This is better than depending upon internal governing, but it will not fulfill all requirements.

Take, say, the case of an extensive heating system, supplied with low pressure steam through a reducing valve, shown diagrammatically in Fig. 1, which shows only the steam main.

According to the above rule, the governor pipe would be connected at the point *A* and would maintain the reduced pressure constant at that point. Although shown as a dry pipe, this connection should be trapped, as is the governor pipe to point *B*.

Let us say that the valve is set for 5 psi reduced pressure. It is obvious that, as the load varies, the pressure at the point *B* (the extreme end of the line) will vary and may even drop to atmosphere or below, due to the vacuum caused by condensation of steam in the radiators. It is obvious, therefore, that the valve will have to be adjusted, as the load conditions vary, in order to maintain any definite pressure at *B*. In other words, the pressure required at *A* is variable, depending upon the steam demand, and not a constant quantity. It is, therefore, acting upon a fallacious principle to govern the valve from the point *A*.

Governor Pipe Connection

Under such conditions, the "feeler" (or governor) pipe should be connected to the main at the point *B* and the valve be set for the requisite minimum pressure at that point—say 2 psi. If that is done, every radiator and branch main will be supplied with steam at not less than 2 psi pressure, and the pressure at *A* will be automatically variable, as it should be, the increase above 2 psi being that required to compensate for the pressure drop in the pipe between the valve and *B*. The valve once set, no further adjustment of pressure is necessary and the system will continue to supply steam to the radiators and the branch mains at not less than 2 psi regardless of load conditions.

Regardless of the size of tapping for its connection to the valve body, the governor pipe should be of reasonable size (i.e., not too small) and the manufacturer should be consulted on this point and his recommendation followed. This pipe, being trapped, should be provided with some means for draining in case of repairs, etc. If a cock or valve is used, provide a capped nipple on the outlet, so as to be sure it is tight.

"Heat Balance" for Valve

As regards the "heat balance" for a steam pressure reducing valve, accepted authorities say that, as in any orifice throttling, the total heats on the inlet and the outlet sides are equal. It may also be said, however, that the allocation of this heat is different on the two sides.

Let us take, say, a reducing valve supplied with steam at 50 psi gage and reducing it to 5 psi gage. At 5 psi the latent heat is about 49 Btu per lb greater than that at 50 psi, while the heat in the liquid is some 71 Btu less. The difference, approximately 22 Btu, is the difference in the total heats at the two conditions and the result is a slight superheat in the reduced pressure side. This is utilized in "flashing" or re-evaporating moisture in the steam, the excess (if any) being soon dissipated by radiation losses, etc.

It is for the above reason that it is often said that the use of a reducing valve tends to compensate for line condensation.

One word more. Throughout the foregoing discussion, the assumption has been that the steam supplied to the valve is saturated steam in a reasonably dry condition. If superheated steam is to be used, the picture changes and the safe thing to do is to consult a reputable manufacturer of reducing valves and follow his recommendations.

Predicts Increased Volume of Air Conditioning as Result of War Job

A. C. Buensod Sees "Continuing and Increased Volume," Urges Preparation of Blueprints and Paper Work Now to Speed Construction When Critical Materials Are Released; Summarizes Refrigerant Situation in Report at HPACCNA Annual Convention

AIR CONDITIONING "of continuing and increased volume" for industrial processing and for comfort was predicted by A. C. Buensod, president of the contracting firm of Buensod-Stacey, Inc., in his report as chairman of the committee on air conditioning of the Heating, Piping and Air Conditioning Contractors National Association given at the HPACCNA's 55th annual convention in Cleveland early last month. While new installations for comfort have been prohibited during the war in order to conserve critical materials and manpower, hundreds of installations for war production covering a wide range of applications vital to the nation's productive capacity have subjected many thousands of people to the benefits of more comfortable working conditions and the attendant increase in efficiency has contributed greatly to the success of our war production program, he said. Use of air conditioning for controlling process work and for contributing to increased efficiency of workers will be expanded in peacetime as a result, he predicted.

In regard to the refrigerant situation for comfort cooling, Mr. Buensod read a letter from F. B. Millham, assistant chief of the special equipment branch of the general industrial equipment division of the War Production Board, in which Mr. Millham stated that shortage of critical materials may delay full capacity operation of the new East Chicago "Freon-12" plant and thus will require the continuing of present restrictions on use of this refrigerant in air conditioning "until at least the fourth quarter of 1944 or the first quarter of 1945." Small amounts of the refrigerant are set aside monthly*—depending on production and on requirements for essential uses—to provide for the maintenance of air conditioning systems in "windowless" or "sealed" buildings and buildings containing a high percentage of unventilated interior space, where such buildings are used for offices, restaurants (not night clubs), cafeterias, department stores, hotels and schools, according to Mr. Millham.

Mr. Millham's letter also summarized the situation in respect to the refrigerant "Freon-22." He said that the shortage of this refrigerant has occurred due to reasons beyond the control of either the producer or the WPB. Conservation of this gas is being effected by the restrictions on its use contained in order M-28-a. Further restrictions were necessary after the order was issued and are set forth in a directive to the producer. Briefly, these additional restrictions prohibit the delivery of "F-22" except for use in low temperature equipment, designed to use this gas as the refrigerant, such as variable temperature cabinets for the testing of aircraft instruments, low temperature metal shrinking cabinets, and refrigeration for the production and storage of penicillin and blood serum. Where the amount required is more than 375 lb, special authorization must be obtained from the WPB; applications for such authorization may be made by addressing a letter to the General Industrial Equipment Division, War Production Board, Washington, D. C., Reference: M-28-a. It is not expected that the "F-22" situation will improve much before October 1, 1944, he concluded.

Despite present restrictions on installation of new air conditioning systems for comfort, and shortages of refrigerants, Mr. Buensod feels it would be a wise policy for anyone contemplating any building facilities, or comfort air conditioning which will be required in the immediate postwar era, to plan now and prepare all the necessary blueprints and paper work so that when construction is permitted and critical materials released, the work can be immediately started.

His own organization has several contracts for work of this character, in which all paper work and detail plans are ready so that when authorized they can immediately proceed to order equipment and materials to take advantage of the opening of this civilian market. Otherwise, it will take weeks or months to plan and thereby there will be delays that might not be desirable.

Most of the work that his organization has on this basis is industrial, where factories are to be expanded.

DANIEL HAYES ELECTED PRESIDENT

Daniel Hayes was elected president of the Heating, Piping and Air Conditioning Contractors National Association last month. From San Francisco, he is the first president of the association from a Pacific Coast city. Elbert W. Verity of New York was named vice-president, and Thomas L. Eagan, Washington, D. C., was elected treasurer.

John S. Jung, L. L. McConachie, George P. Nachman, W. J. Olvany, William Sodemann, Ray Berry, L. F. Hudepohl, Wray M. Scott, and Messrs. Hayes and Eagan, were chosen members of the board of directors.

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*Order M-28 as amended July 5, 1944.

Contractors Devote Busy Afternoon to Developing Pipe Welding Program

Great Interest Shown in Talk on Future of Welding, Demonstrations of Methods of Welding Pipe and Testing Coupons, and Committee Reports . . . Aim of Association's Program Is to Give the Owner the "High Quality of Welding He Has a Right to Expect"

SPEAKING AT an afternoon session devoted entirely to welding, J. F. Lincoln, president of the Lincoln Electric Co., addressed the Heating, Piping and Air Conditioning Contractors National Association on the future of welding, at its annual convention last month.

Mr. Lincoln said that our lives are radically different now as compared to 50 years ago because of mechanical developments, and he pointed out that undoubtedly industrial progress in the next 50 years will be even greater than in the past 50 years. He called on the association members to give their imaginations free rein, stating that there were newer and better ways of doing almost everything in industry if people were only smart enough to figure them out. It is probably safe to say, he felt, that "everything we are doing now is wrong, as there's always a better way."

Complimenting the HPACCNA on the work it is doing to simplify welding procedures and practices, Mr. Lincoln traced the development of the welding industry through the early days of hamstringing legislation and restrictions, up until the present time, where it is a "useful, valuable, and economical method of fabricating everything made of metal." He pointed to a bright future, and said that less than one out of every three places where the application of arc welding could be helpful are now using the process.

After Mr. Lincoln's address there were demonstrations of arc and gas welding on piping, and the testing of coupons, which were explained and supplemented by the practical comments of John H. Zink, chairman of the association's editorial committee for the Standard Manual on Pipe Welding, and others.

At the same session, E. P. Everhard, chairman of the association's committee on welding, reported that during the year the committee has continued the work of revising the standard welding procedures to bring them up to date and suitable for adoption by the newly-formed National Certified Pipe Welding Bureau. Any welding operator qualified on a given process according to the present procedures is acceptable on that process under the revisions without requalification, he said.

In the report of the secretary, Joseph C. Fitts announced that the association's apprenticeship program has been given impetus by the publication of a new edition of the Instruction Manual for Steamfitting Apprentices, the work comprising three volumes covering pipe work and heating; steam power and refrigeration; and air conditioning, process piping, and welding and brazing.

The excellent attendance at and interest shown in the afternoon devoted to welding at the HPACCNA convention was something in the way of a tribute on the part of the membership to the association's welding program, which covers "the training of journeymen steamfitter welders, the maintenance of first class modern equipment, and constant supervision of operators to see that procedures are followed and quality maintained." The aim of the entire program, in the words of the association, is to give the owner the high quality of welding he has a right to expect.

Roy M. Getschow, chairman of the board of trustees of the National Certified Pipe Welding Bureau, told the convention of the progress made in organizing the bureau. Local bureaus are set up in several cities, and it is expected that the national group will be functioning soon through these groups. Mr. Getschow stressed the advantages of having available a pool of tested welding operators and the saving in time and expense now involved in testing journeymen whenever they change employers.

MAINTENANCE AND REPAIR WORK IN INDUSTRIAL PLANTS

Industrial plant piping systems are transportation systems, and—like other transportation systems—must be designed for efficiency and properly managed. Responsible heating, piping, and air conditioning contractors offer to industry the management service and installation experience, continuous inventory of tools and materials, skilled men already trained, and efficient supervision for handling maintenance and repair of plant piping services, according to a report given at the annual convention of the Heating, Piping and Air Conditioning Contractors National Association held in Cleveland last month.

According to the report, one association member has a maintenance and repair contract with a steel mill and averages around 75 men on the job. Another stated that in 1943 he had business amounting to $150,000 from industrial maintenance and repair work. Another member said that he went into a plant for a small job and has since been sent into three other plants owned by the same company to do the same kind of work.

Members of the association were urged to sell their maintenance and repair services to industrial plants.

Stoker Manufacturers Study Conservation of Fuel and Consider the Postwar Outlook

Standard Codes for Testing and Rating Underfeed Stokers Adopted at Annual Meeting; Research on Stokers and Stoker Coals Recommended; Design of Boilers for Stoker Firing Given Consideration

THE TWENTY-SEVENTH annual meeting and the third annual war conference of the Stoker Manufacturers' Association were held at French Lick Springs, Ind., last month with 130 members and guests in attendance. Discussion and consideration of many problems and subjects of direct interest to the stoker industry were divided between current fuel conservation programs and postwar plans for the industry. No formal papers were presented and the meeting was conducted in the form of a conference with reports from officers and chairmen of the association's various standing committees leading the discussions.

The association took under advisement the possibility of initiating a cooperative national advertising and sales promotional campaign on automatic coal heat. The matter was referred to the executive and advertising committees with instructions to prepare tentative proposals on the types of campaigns which would most likely fit postwar marketing and economic conditions. These committees will prepare a complete report to be presented to the executives of the industry at the regularly scheduled fall meeting of the association.

Current conditions in the stoker industry were fully discussed. Emphasis was placed on the importance of the early sale and installation of class A commercial and industrial stokers in order to realize the maximum benefits in the conservation of critical hand fired coal sizes next winter. Industry leaders and government officials urged all manufacturers to feature fuel conservation in all of their national and local advertising efforts.

The association adopted standard codes for the testing and rating of underfeed stokers up to 1200 lb per hr of coal for both bituminous and anthracite machines. Specific recommendations on the design of boilers for stoker firing were also adopted and will be transmitted to the cast iron and steel heating boiler industries for their consideration. These recommendations were made as a result of a series of conferences with engineering representatives of the national boiler organizations. The SMA has also adopted several recommendations as to research projects on stokers and stoker coals which it is transmitting to Bituminous Coal Research, Inc., for its consideration. This, too, is the result of a series of conferences between stoker engineers and executives and coal research engineers and executives held within the past few months.

Representatives of government agencies and the coal industry attended the meeting and discussed current problems concerning stoker production, priorities, materials, manpower, fuel conservation, and fuel supplies.

J. M. McClintock, manager of the stoker division, Illinois Iron and Bolt Co., was re-elected president of the association for the third term. Walter Sormane, sales manager, Schwitzer-Cummins Co., was re-elected vice president, and George W. Graham, president, Eddy Stoker Corp., was re-elected secretary-treasurer. Milton A. Young, sales manager, Catskill Metal Works, was re-elected chairman of the association's anthracite section. Marc G. Bluth was reappointed executive secretary. Headquarters office of the SMA is at 307 N. Michigan Ave., Chicago 1, Ill.

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Fire Hazards of Air Conditioning Systems

MR. NEALE'S article in the June HPAC emphasizing the necessity for proper design of air filter installations on the drafting board and good housekeeping after installation brings out two very important factors in eliminating possible fire hazards in air conditioning systems.

The cooperation of air filter manufacturers with the fire underwriters has resulted in the elimination of some unsatisfactory designs and methods of installation. New materials and new techniques developed in the war effort will probably give greatly increased safety in postwar applications. In my opinion, an air filter—almost any properly designed air filter—can be a fire protection measure if adequate consideration is given to laying out the system. It prevents inflammable deposits in the air ducts, collecting such material at the entrance to the system where it is readily observed and easily removed.

The question of housekeeping after the installation of air filters is extremely important. The air filter may be entirely fireproof but the dirt collected on the face of the filter is usually inflammable. Unless such deposits are removed on a regular schedule, they may constitute a hazard.—H. C. MURPHY, vice-president, American Air Filter Co., Inc.; member of HPAC's board of consulting and contributing editors.

STEAM UTILITIES SOLVE WARTIME PROBLEMS, PLAN IMPROVEMENTS

On June 14 and 15 members of the National District Heating Association assembled in Pittsburgh for their 35th annual meeting to hear addresses by guest speakers, reports of association officers, and papers by technical committees. Possibly the most important topics discussed were conservation of fuel, lengthening the life of critical equipment and material, and what to expect at the war's end.

First of the guest speakers on the busy program was Theodore F. Smith, president and director of the Oliver Iron and Steel Corp. and director of the Pittsburgh Chamber of Commerce and many other organizations. Speaking as a member of the national Committee for Economic Development, he explained how leaders of industry, labor, agriculture, transportation, banking, commerce, distribution, and civic and patriotic interests were banded together in this organization. He told how at their most recent meeting members of each of the constituent groups had clarified the problems confronting them as regards contract termination, removal of government property, disposal of plants and surplus equipment and supplies both here and abroad, demobilization of soldiers and war workers, termination of wartime controls, agriculture, taxation and capital, government plant operation or scrapping, and surplus food.

He predicted that industrial demobilization is rapidly approaching and that cut-backs will mean painful readjustments for many companies. He felt, however, that the filling of remaining war and essential civilian requirements will cushion the blow. He said that industry is ready to start work on reconversion and civilian goods production but is held back by government restrictions.

On the subject of guarantee of employment, he said that industry is not only expected to do this, but of late it is proposed that it guarantee an annual wage. He said, however, labor must work efficiently, and under the American system employment fluctuates with the demand for products. With this in mind, manufacturers are planning now for new products, for new uses of old products, to improve designs, and for greater efficiency of manufacture, enabling lower costs, greater distribution, and greater employment.

He added that if a manufacturer employed more labor than he needed, his costs would rise. He could do this only if all his competitors did likewise. This would require government aid and result in national socialism, he said, and claimed that government "make work" projects should not be of such a nature as to lower the standard of living in their accomplishment.

In conclusion, he said that government must create conditions favorable for enterprise and that industry in its program needs the help of both the people and the government.

Building Heating Cost

The second speaker on the program of the sales development committee, of which Robert D. Martin is chairman, was R. J. J. Tennant, one-time district heating man and now chief engineer of Pittsburgh Business Properties, a company holding and operating much downtown real estate. Mr. Tennant's topic was From the Other Side of the Fence. As a member of the National Association of Building Owners and Managers, he told the district heating meeting of the problems of their chief customers, which he said they should know.

He said that building operating costs have risen 15 per cent while income has not risen as much and that either costs must come down or income rise. He said that while they had been able to prove there was no need of rent control in large buildings and had won a decision that the 40 hr law did not apply to them, they had many other difficulties. They were limited to a yearly expenditure of $1000 for construction in each building. The manpower problem is acute.

Demolition of buildings in downtown areas, he pointed out, is a problem of interest to both building owners and heat suppliers because the buildings that replace those removed have, as a rule, a less volume. The causes, he said, are high taxes and high valuations and the remedy would be a shift in taxation.

Mr. Tennant gave heating cost figures. He said these varied from 2.3c per sq ft of rentable area in southern cities to 11.7c in northern ones. The average cost of heating and ventilating is 5.8c per sq ft of rentable area. Thirty-eight per cent of the 317 buildings for which detailed heating costs are available use purchased steam service. To heat 21,500,000 sq ft of rentable area costs 5.1c per sq ft.

In closing, he predicted a period of closer competition after the war and advised the utilities to advertise the advantages of district heating service, to give customers all useful information on how to heat economically, to be frank with customers regarding problems, and to design rates to make it possible to take on loads now missed within their service areas.

A member of the NDHA's sales development committee, Harry A. Weitzman, of the Rochester (N. Y.) Gas and Electric Corp., spoke on expected postwar conditions. He said that companies replying to his questionnaire said they had obtained war business equal to from 0 to 50 per cent of their former business volumes, that they expect to retain from 10 to 75 per cent of this new business, and that in from three to five years after the end of the war they expect a 10 per cent business increase. Additional steam use will be required for air conditioning and process work, he stated.

He learned the utilities are planning improvements in generating, such as new boilers to replace old and less efficient ones, new fuel burning equipment and higher steam pressures—and in distribution by loading up systems, building tie lines, rebuilding old lines, and making needed major extensions.

Wartime Steam Customers

Since the liquid fuel shortage, in Boston as in other seaboard cities building owners have arranged to replace oil heat in their buildings with district heating service where it is available. Henry L. Martin of the Boston Edison Co. reported that on announcement by the government of the scarcity of fuel oil there had been an influx of inquiries and signed contracts, many of them by prospects with whom the company had cordial relations, until the available spare capacity of the boilers was taken and they could add no more business.

He said they required new customers to agree to keep their steam generating plants in repair for emergency use. They connected no buildings with coal fired boilers because coal was available and the use of critical material would be required. Some unusual steps were taken in the emergency. Three customers were sold steam for temporary power generation on their premises. Three were sold electricity.

He said all connections were made with the idea of permanency. Needed equipment was installed to make the buildings use steam economically. Otherwise dissatisfaction with the excessive use might be expected to result in a business loss after the war. Company engineers handled all change-over details and negotiations for the customers.

When materials are available, Mr. Martin said, the company must install adequate generating capacity for all. The present attitude of the utility should influence the customers' choice of heating fuel when competition is again existent. He must be made aware of the hidden benefits of purchased steam service.

John H. Sorg, member of the Allegheny County Bar, was the guest speaker at the get-together luncheon on June 14. Mr. Sorg had studied in Germany and later made several business trips to that country before the war. He pictured vividly the insidious progress of Hitlerism and concluded with a warning to Americans to guard their liberties.

Chairman Leonard S. Phillips, New York Steam Corp., reported that the war service committee, following a meeting with governmental conservation agencies, had recommended to the association executive committee that member organizations be asked to make an even greater effort than is done at all times to conserve fuel and also manpower, transportation, and critical materials. George H. Tuttle, The Detroit Edison Co., of the commercial relations committee, which had been assigned the task of communicating with the steam utilities on this subject, said the assignment had been completed and it was evident from copies received that the utilities had sent to their customers literature urging saving and that they had cooperated wholeheartedly.

Advise Temperature Control

He said that unfortunately due to lack of uniformity in reporting, it was impossible to determine the extent of the results. However, on a sq ft of radiation basis and on a cu ft basis and also per customer, the steam use is lower. He said the utilities had urged their customers to improve their buildings and install temperature control equipment.

Among the recommendations made by the advisory committee—a group composed of four utility representatives, four manufacturers, and a chairman—presented by their chairman, E. E. Dubry, The Detroit Edison Co., was one that efforts be made to produce equipment which would better withstand wear, erosion, and corrosion.

In a paper on the industry's rate problems, plans, and objectives, Harry A. Weitzman, manager of the rate and contract department of the Rochester Gas and Electric Corp. and member of the association rates and regulations committee, reported that answers to questionnaires sent out by him indicated that new problems were of a relatively minor nature and too few studies of rates were contemplated.

In concluding, he suggested studies of tax and fuel adjustment clauses, the desirability of interruptibility of service clauses in contracts where mains and/or plant are inadequate in peak loads and leased boilers are not available, the desirability of customer contributions for line extensions, the effect of shifting peak load, the inducement type of rates for peak and offpeak service and costs.

Improved Load Factors

J. Earl Seiter, Consolidated Gas Electric Light and Power Co., presented two valuable papers. In the first of these, on capacity, load factor, and rates, he showed that improved load factors inevitably bring lower unit costs to both the company and the customer. The companies reporting to Mr. Seiter each indicated that the load factor rates either helped them to retain existing business or to obtain new customers or both. In the second paper, on rate structure analysis, Mr. Seiter gave a very comprehensive review of the fundamentals of rate making.

Sterling S. Sanford, sales engineer of The Detroit Edison Co., was elected president of the association for the year 1944-45, at the final session. Roy M. McQuitty, utilization engineer of the Union Electric Co. of Missouri, was elected first vice-president; John F. Malone, supervisor of district steam sales, Consolidated Gas Electric Light and Power Co. of Baltimore, second vice-president; and Robert D. Martin, assistant vice-president and director of the New York Steam Corp., third vice-president.

These men, with the retiring president, J. J. Schenk, Rochester Gas and Electric Corp., Henry L. Martin, Boston Edison Co., and D. W. Loucks, Allegheny County Steam Heating Co., form the new executive committee. John F. Collins, Jr., is secretary-treasurer of the NDHA, with the headquarter's office at 827 N. Euclid Avenue, Pittsburgh 6, Pa.

[Reports of the commercial relations, insurance, operating statistics, research, weather data, chemistry, steam station engineering, educational, and distribution committees will be summarized next month.]

Refrigerating Engineers Discuss Psychrometry in Frost Zone, Heat Flow, Refrigerants, Test Setups

IN A CAREFULLY prepared paper which attracted wide and favorable interest, D. D. Wile—of the Carrier Corp.—discussed Psychrometry in the Frost Zone at the 31st spring meeting of the American Society of Refrigerating Engineers. The meeting was held in Pittsburgh early last month.

Mr. Wile pointed out that humidity measurements in comfort air conditioning and industrial processing are made almost exclusively by the wet bulb psychrometer. In meteorology, the psychrometer finds universal use even at the extremely low temperature of Arctic regions. The psychrometer is also used in engineering practice at temperatures below freezing, but its reliability in this field has not been so well established.

Of the several methods available for measuring humidity at low temperatures, the psychrometer combines the advantages of simplicity, low cost, ease of manipulation and commercial availability, and when properly used, it is entirely reliable, he said. The purpose of his paper was to recommend the practices and precautions necessary to obtain reliable readings with the wet bulb psychrometer in the frost zone, clarify the theoretical principles involved, and establish the magnitude of errors that may exist under various operating conditions.

In concluding his discussion and presentation of data, Mr. Wile gave the following summary of factors affecting the psychrometer:

Thermometer Accuracy—By far the most important source of error at low temperatures is the thermometer. Fortunately, this error can be reduced to negligible proportions by selecting thermometers with suitably fine graduations. Furthermore, almost any desired accuracy can be obtained from suitable thermocouple equipment.

Supercooled Water—At temperatures near freezing, if the wick is wetted with supercooled water and calculations are based on ice, large errors may result. Complete elimination of this error is simply a matter of using the proper type of psychrometric chart or of using the proper physical constants in the calculations.

Thermometer Stem Correction—At low temperatures, this error is usually negligible and it can be easily corrected by application of a simple calculation.

The stem correction can be expressed as a per cent of the wet bulb depression:

$$\frac{\text{Stem correction}}{\text{Wet bulb depression}} \times 100 = 0.009\ (N - t_1)$$

where N = the scale reading at the point of immersion and t_1 = thermometer reading.

Results of this equation are given in the following table for various degrees emergent from 0 to 80:

No. of degrees emergent ($t_1 - N$)	Stem correction, per cent of wet bulb depression
0	0
20	—0.18
40	—0.36
60	—0.54
80	—0.72

It is evident that at low temperatures, where the number of degrees emergent is small, that the stem correction can usually be considered negligible.

Air Stream Velocity Effect—At low velocities, the psychrometer tends to indicate too high a humidity, while at high velocities, the indication is slightly too low. Formulas and curves presented in this paper make it possible to select a velocity at which the error is nil, or to correct for the error at other velocities.

Radiant Heat—The psychrometer must not be shielded from objects at dry bulb temperature but it should be shielded from surfaces which are considerably above or below dry bulb temperature. Care must be taken to avoid radiant heat from the observer's body. These precautions are particularly important at low temperatures.

Impact Effect—In a moving air stream, both the wet and dry bulb thermometers indicate temperatures slightly lower than the true values for the air at rest. Since both thermometers are affected alike, the error is negligible except at very high velocities. A correction can easily be obtained from a table given in the original paper.

Dalton Effect—At some future date, the psychrometric tables may be revised to show moisture contents slightly higher than indicated by the perfect gas law. At low temperatures, the revision will be of negligible magnitude. Engineering practice usually concerns the difference in moisture content between two states and thus further reduces the significance of this deviation.

Heat Flow Rates With Rapid Temperature Changes in Enclosed Spaces

In their paper on Heat Flow Rates With Rapid Temperature Changes in Enclosed Spaces presented at the ASRE meeting, H. B. Pownall and S. P. Soling, of the York Corp., gave a method whereby quick pulldown installations may be rationally designed. They showed that:

The heat flow rate is dependent primarily upon the temperature difference between the air and the various surfaces exposed to the air, and only secondarily upon the heat capacity of the objects comprising these exposed surfaces.

At any time instant a balanced condition must exist between the compressor capacity and the rate of heat flow from the exposed surfaces.

For any given system a curve plotted showing temperature versus time will have a well defined knee past which the time rate of change of air temperature becomes very slow.

Refrigerants and Absorbents

Speaking on Refrigerants and Absorbents at the ASRE spring meeting, W. R. Hainsworth, vice-president of Servel, Inc., reviewed desirable refrigerant and solvent properties and characteristics for compressor and absorption systems. In concluding his paper, he stated that with so many basic refrigerant variables entering the design it is understandable that ideal refrigerants for all applications do not exist. Water may be an ideal refrigerant because of its high latent heat and safety characteristics but its temperature range is limited, the displacement requirements are high, and leaks are difficult to find in a high vacuum system. Ammonia has a high latent heat, good displacement characteristics, and is capable of use over a wide temperature range. However, its large scale usage is mainly in industrial applications, partly because of the high cost of safety requirements in many other types of installation. Methyl chloride and sulfur dioxide have their advantages and disadvantages. The "Freon" refrigerants have an economic advantage in safety requirements, but the economy of operation in industrial applications is not so low as ammonia, and leaks are more difficult to find. The ideal refrigerant does not exist, but ideals are still worth working for and it would be unreasonable to assume that there will be no more new and improved refrigerants.

The road from the laboratory to acceptance by industry is long and hard and requires a great deal of courage and ability on the part of the chemical companies who undertake to produce, cooperating with the refrigerating companies who undertake to use, a new refrigerant, said Dr. Hainsworth. It is possible that when new refrigerants and absorbents do appear they will be of a type which will permit the use of smaller equipment without much change in operating efficiency. The organic chemist can synthesize almost any compound he wishes to create. He has new scientific tools to work with. Just one of these is the new infra-red spectrometer which enables him to produce an automatic recording to identify many radicals and their position within the molecule. He can tack on halogen atoms here and there, and intersperse double bonds or polarize and unbalance the molecule with side chains. He can plaster the whole carbon chain with fluorine or other components if he wishes. He may even find a thermal and pressure reversible polymerization reaction attended by heat changes larger than the latent heat of evaporation. What will be the result? Possibly a new refrigerant. Possibly a new absorbent.

Control of a Temperature-Altitude Chamber

The subject of control of test chambers, and their design and construction, came up for as much or more discussion as any other topic, following presentation of a paper on Control of a Temperature-Altitude Chamber by F. W. McKenna, of the Vilter Mfg. Co. He described the design of a test chamber at an aircraft radio laboratory which is subject to automatic program control of both temperature and pressure. This was one of the most interesting and unique control problems ever submitted to us, he said. "We had never previously attempted a control application of this nature, and to the best of our knowledge neither had any one else in the industry."

The specifications required that the equipment should be capable of reducing the temperature in the chamber from ambient (approximately +80 F) to —76 F in 2 hr, holding this temperature 4 hr, raising the temperature to +167 F in 45 min, then holding the temperature until the end of the test.

In addition to the temperature requirement, it was also necessary to reduce the pressure in the chamber to 4 in. Hg absolute in ½ hr after the temperature had been reduced to —76 F.

The temperature and the pressure were to be controlled and recorded, and the air in the chamber was to be circulated in order to maintain an even temperature. Vibration would not be tolerated because of its effect on equipment under test. This included mechanical vibration as well as vibration attributable to excessive air velocities.

A program controlled semi-automatic system that would meet specifications was worked out. By presetting the controls, an infinite variety of reproducible test programs is available. The temperature and pressure controls are independent of each other.

In addition to the papers reviewed briefly above, the meeting program included discussions of hydrocarbon refrigerants in the low temperature field, by H. D. Edwards, Linde Air Products Co.; blast freezing plants, by Earl D. Pollock, Vilter Mfg. Co.; chromate corrosion inhibitors in brine systems, by Marc Darrin, Mutual Chemical Co. of America; use of cold cathode fluorescent lighting in refrigerated spaces, by R. C. Hultgren, General Luminescent Corp., domestic refrigerators, by Arthur W. Ewell, Worcester Polytechnic Institute; industrial plastics, by John Sasso, Product Engineering; refrigeration in water-gas synthetic ammonia plants, by J. G. Dely, consulting engineer; efficient use of insulation, by L. E. Cover, Armstrong Cork Co.; determining thermal conductivities at low temperatures, by Ludwig Adams, Mellon Institute; and refrigerating test equipment, by Robert W. Christie, U. S. Testing Co., Inc.

At a luncheon meeting, George R. Gibbons, senior vice-president of the Aluminum Co. of America, described the many wartime uses of aluminum and the large amounts of this metal available now and for postwar use. Pig capacity has been expanded seven times during the war, and fabricating capacity has been expanded 30, 40, or 50 times, he said.

The invasion of Europe occurred while the ASRE was meeting in Pittsburgh, and to keep the refrigerating engineers up to the minute on war news, a commentator from one of the local radio stations gave a news summary at the end of each morning technical session.

Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Proceedings of the Semi-Annual Meeting

American Society of Heating and Ventilating Engineers
June 19-20, 1944

ONE OF the most important actions taken by members of the American Society of Heating and Ventilating Engineers attending the Semi-Annual Meeting 1944 in Grand Rapids, Mich., was the adoption of a resolution offering "the full support of the members of the ASHVE to the Government in the National Fuel Efficiency Program to expedite the war effort by helping to prevent the needless waste of heat and power."

The Semi-Annual Meeting of the Society attracted over 350 members, guests, and ladies at the Pantlind hotel, Grand Rapids, June 19-20. After a series of important committee meetings on June 18, the first business session was called to order on Monday, June 19, in the ballroom of The Pantlind by Pres. S. H. Downs, Kalamazoo. A greeting for the visiting members was given by H. D. Bratt, president of the Western Michigan Chapter, as follows:

> Good morning Officers and Members of the American Society of Heating and Ventilating Engineers! To say that the Western Michigan Chapter welcomes you to Grand Rapids is to use a true, if you will, but stereotyped expression, but we hope that you will enjoy your visit to the home of this little daughter of the big mother Society.
>
> Because of her leadership in furniture design and craftsmanship, Grand Rapids is known as the Furniture Capital of America. And yet her industries are widely diversified. Fifty-nine per cent of our families here own their homes, and that is a high rate, as cities go, in the United States.
>
> These facts make for economic stability and I give them to you to make you feel that you have come to a pretty good place after all.
>
> Attendance at our Chapter meetings during these two and a half years of war has been very good, in spite of the fact that half our members must drive 50 miles or more to attend the meetings under gasoline rationing restrictions. We are proud to announce that since the first of the year our Chapter has increased its membership about 50 per cent. But we are proud most of all to welcome home our most distinguished member, who has been hopping all around the country on a speaking tour. To you he is known as Pres. S. H. Downs, but to us he is known as Sewell.
>
> I am very happy to say to you, Sewell, we wish you complete success, and we assure you that we will do all in our power at this meeting to make things enjoyable for everyone.

A brief response was made by President Downs.

By-Law Amendments

A series of amendments to the By-Laws and Research Regulations were presented by Secretary A. V. Hutchinson. The new By-Laws on rate of initiation fees and dues are as follows:

ARTICLE B-IV — Admission Fees and Dues

Section 1. The admission fee of Members and Associate Members shall be ten dollars ($10.00); of Junior Members five dollars ($5.00). Admission fee must accompany application for membership.

Motion for adoption was made by C. F. Boester, St. Louis, and seconded by E. C. Evans, Buffalo, N. Y.

Section 2. The annual dues of Members and Associate Members shall be eighteen dollars ($18.00); of Junior Members ten dollars ($10.00); of Student Members three dollars ($3.00).

A motion for adoption was made by L. T. Avery, Cleveland, and seconded by E. M. Mittendorff, Chicago.

Section 5. Of the annual dues paid by Members and Associate Members forty per cent (40%) shall be *allotted* to the Research Fund and shall be immediately deposited in said fund and shall not be used for any other purpose.

Motion for adoption was made by G. D. Winans, Detroit, and was seconded by H. B. Hedges, Philadelphia.

Section 7. The dues of a new member of any grade shall be pro-rated quarterly but if the amount paid is less than five dollars and fifty cents ($5.50) such member shall not be entitled to receive the volume of Transactions or The Guide for the year in which he is elected, but he shall otherwise be entitled to all the rights and privileges of membership. Forty per cent (40%) of all dues of Members and Associate Members shall be allotted to the Research Fund and shall be immediately deposited in said fund and shall not be used for any other purpose.

Motion for adoption was made by M. W. Bishop, Milwaukee, and seconded by John Howatt, Chicago.

Section 8. Junior Membership shall be limited to ten (10) years and upon election to a higher grade, such members shall upon notification of transfer, pay the annual dues of the grade to which they have been transferred.

Motion for adoption was made by L. G. Miller, East Lansing, and seconded by J. W. Miller, Lansing.

The several motions for adoption were unanimously carried.

President Downs announced that the proposed amendment on Committees, Article B-VIII would be presented by J. F. Collins, Jr., Pittsburgh. Mr. Collins said that Chapter Delegates Conferences had been held for a number of years at each Annual Meeting and last January the group decided they would like to be considered as a Society Committee and to accomplish this directed their chairman to appoint a committee of three to prepare an amendment to the By-Laws. It was not the purpose to take over the functions of any of the other committees, such as Membership, Chapter Relations, or did they say that they wanted funds to come to each Society Meeting. The proposed amendment was sent to the Chapter Delegates, and 25 of the 32 expressed approval, and 4 did not vote.

Mr. Collins then offered a motion for the adoption of the amendment, which was seconded by D. L. Taze, Cleveland.

ARTICLE B-VIII—Committees

Section 14. There shall be a standing committee known as the Chapter Delegates Committee. The membership of this Committee shall consist of one Delegate or Alternate from each local chapter, who shall be selected as each chapter may direct. The Chapter Delegates Committee shall meet at each Annual and Semi-Annual Meeting of the Society to discuss problems of mutual interest affecting the chapters. The Chapter Delegates shall elect a chairman to serve for a term of one year, from June to June. Meetings of the Chapter Delegates Committee may be attended by any local chapter officer, but each chapter shall have only one vote.

In the discussion John Howatt, chairman of Constitution and By-Laws Committee, expressed the opinion that the proposed amendment should have been referred to the Council, and if the Council saw fit it would refer it to the Constitution and By-Laws Committee for preparation in proper form. He pointed out that in the present By-Laws, provision is made for 12 regular committees and that the By-Laws stipulate that the Council may appoint any other special committees to carry out any specific purposes. He suggested that there should be a definite clarification of the functions and duties of some of the existing committees before we create committees without any specific functions.

Mr. Howatt recalled that the Chapter Delegates Conference was established when he was president of the Society, but he felt that the Chapters Committee should do something more than just "discuss" matters.

Mr. Collins expressed the opinion that the division between the Chapter Relations and the Chapters Committee was quite clear cut, and felt that any recommendations made by the Chapters Committee to the Council would naturally be referred to the Chapter Relations Committee.

Mr. Avery stated that the discussion brought out the fact that there was a question whether the Constitution and By-Laws Committee is a steering Committee, or whether it is an approval committee. He thought that it was rather unfortunate that our Constitution permitted different methods of revision for the Constitution, the By-Laws and the Rules.

President Downs pointed out that there was an apparent conflict between the proposed amendment and the Rules where the Chairman would serve from June to June, and invited discussion of this matter.

In commenting, C. F. Boester, St. Louis, said that the members of the Committee would serve from January to January, but only the Chairman would serve from June to June. He believed that this was desirable because many of the chapters changed officers at their May meetings.

Motion for the adoption of Section 14, Article B-VIII, was carried.

On motion of Mr. Collins, seconded by Mr. Boester, it was voted that the present Section 14 of Article B-VIII of the By-Laws, edition of 1943, shall be renumbered Section 15. This motion was unanimously carried.

President Downs then announced that the following amendment was submitted in accordance with the vote of members at the 50th Annual Meeting in January 1944, and was prepared by the Constitution and By-Laws Committee and endorsed by the Council:

Addition to Article B-IX—Election of Officers

Section 1. . . . . However no member of the Society is eligible for nomination for election to serve on more than one elective body of the Society at a time

Addition to Regulations Governing Committee on Research—Article II—Organization—Section 1 (additional item f)

(*f*) No member of the Society is eligible to serve on more than one elective body of the Society at a time.

It was moved by Mr. Howatt, seconded by Mr. Evans, that the amendment be approved.

Dr. B. M. Woods, Berkeley, Calif., stated that all members of the Society are generally in sympathy with the purpose of the amendment, but he thought that two conditions must be safeguarded, one in which the Society membership is limited on Committee assignments so that only a few men are used, and the other is separation of the Society activities into such watertight compartments that proper correlation is lost. He thought that there had been too much common membership in the last few years, and expressed some apprehension that the amendment as now stated would tend to completely separate the Council and the Committee on Research.

C. M. Ashley, Syracuse, N. Y., stated that his experience as Chairman of the Committee on Research indicated that he would have been greatly handicapped had there not been common membership between the two groups during the past year.

General Danielson said that at one time there was definitely a period when close relationship was lacking, and to overcome the situation the Society changed its regulations so that the Chairman of the Committee on Research became a Council Member, and we thought that was sufficient and remedied the past situation.

F. C. McIntosh, Pittsburgh, stated that the Council nominates members of Committee on Research and frequently accepted suggestions from the Committee and it was his belief that there is good reason for having common membership between the two bodies beyond the Chairman of the Committee on Research, but considered it unnecessary to have a law to accomplish this result.

Comdr. T. H. Urdahl, Washington, D. C., stated that, as a member of both bodies, the dual role has involved a very considerable amount of work. He thought that in the past few years there had been much closer interest between the two elective bodies, but he thought the amendment, in its present form, would not promote the general welfare of the Society.

Mr. Avery reviewed some of the background of the proposed amendment and stated that the point had been raised that seven men held dual positions last January and in accordance with the action of the Society the Council approved the proposed amendment, despite the fact that several Council members had expressed an opposite viewpoint.

General Danielson pointed out that the Chairman of the Committee on Research is now appointed by the President of the Society, whereas previously the Committee on Research elected its own Chairman. This plan permitted closer control over all Society policy.

Prof. G. L. Tuve stated that he thought both the Committee on Research and the Council were doing everything possible for the benefit of the Society in contrast to conditions he had observed in previous years, and said that he was in favor of the spirit of the motion, but considered it too drastic.

Mr. Mittendorff thought the idea very good, but considered that it needed considerable elaboration.

President Downs put the motion to a vote and it was defeated.

A similar amendment to Research Regulations was presented and on motion of Mr. Boester, seconded by Prof. C. H. Pesterfield, it was voted to reject the amendment to Research Regulations, Article II, *Section 1f*.

President Downs introduced Paul D. Close, Chicago, who presented the first paper, Selecting Winter Design Temperatures (see p. 437 in this issue for complete paper).

Following a three-minute intermission, President Downs announced the next paper would be given by L. T. Wright, Jr., Ithaca, N. Y., on the subject of Periodic Heat Flow—Homogeneous Walls or Roofs, who was the co-author with Prof. C. O. Mackey (complete paper and discussion to be published in Journal Section, Heating, Piping and Air Conditioning, September 1944).

The final paper in the morning session was given by E. K. Campbell, Kansas City, Mo., on the subject, A Method of Heating a Corrugated-Iron Coal Preparation Plant (see p. 434 this issue for complete paper and discussion).

[Proceedings to be concluded in August issue.]

Research

Research activities played an important part in the Grand Rapids meeting, for, in addition to the meeting of the Committee on Research on Tuesday afternoon, eleven Technical Advisory Committees also met.

Technical Advisory Committees

The first meeting of the newly formed Committee on Air Sterilization and Odor Control was held on Sunday afternoon, and the general policy under which this Committee will function was discussed and approved.

The Committee on Psychrometry met under the chairmanship of J. H. Walker, Detroit, and agreed on the desirability of obtaining national and, if possible, international acceptance of basic formulas and tables of the properties of mixtures of air and water vapor. They agreed that it was neither necessary nor desirable to establish standard charts because of individual preferences and needs for different types of charts and because charts are merely derivations from the basic data. The Committee agreed to suggest that a joint committee be established with representation from all organizations in the United States and Canada likely to be interested in the establishment of this basic data and that invitations be sent to British Institutions to cooperate. Prof. C. O. Mackey, a member of the Committee, was asked to prepare a report on the present status of our knowledge of the properties of air and water vapor mixtures. After approval by the Committee, a paper will be presented before the Society.

The Committee on Heat Requirements of Buildings met under the chairmanship of Paul D. Close, Chicago, and discussed the proposed studies on infiltration. This Committee hopes to make careful studies during the coming heating season at a number of private residences as well as at research houses in various parts of the country with the hope of establishing dependable data on various factors in the infiltration problem, and specifically on the infiltration in cubic feet per hour for actual wind velocity and the number of air changes per hour per mile of wind velocity.

Following the presentation of the paper by C. O. Mackey and L. T. Wright Jr., Ithaca, N. Y., which resulted from cooperative research between Cornell University and the Society, the Committee on Cooling Load in Summer Air Conditioning met under W. E. Zieber, York, Pa., chairman, and laid plans for a continuation of these studies. Future work will deal with periodic heat flow in non-homogeneous walls and roofs. They also considered the problem of checking by actual tests with a hot-box or other acceptable method the data which had been derived by mathematical analysis and computation.

In the absence of Prof. D. W. Nelson, Madison, Wis., the Committee on Air Distribution and Air Friction met under the chairmanship of Ernest Szekely, Milwaukee, and gave consideration to the urgent need for a re-examination of duct friction data and the question of projection of heated and cooled air streams.

The Committee on Insulation, Lt. Comdr. E. R. Queer, Washington, D. C., chairman, met and discussed the desirability of the Society being in a position to carry out standard tests on heat transmission through insulating and other materials.

A well-attended meeting of the Committee on Air Cleaning was held on Monday afternoon under the chairmanship of R. S. Dill, Washington, D. C. Among the many important aspects of this problem which were discussed in this meeting, the question of a standard code for testing air filters was in the forefront. The Committee was advised that the Air Filter Institute had considered this problem and had appointed a special sub-committee to expedite the preparation of an acceptable code with the intention of submitting it through the Committee and the Standards Committee of the Society for approval by the Society.

Prof. G. L. Tuve, Cleveland presented to an informal meeting of the Committee on Heat Transfer of Finned Tubes some preliminary results of the work being carried on at Case School of Applied Science on heat transfer coefficients of Freon refrigerants.

J. C. Albright, Philadelphia, presented to an informal meeting of the Weather Design Committee the results of the analysis for one city of the comprehensive weather data which has been made available to the Committee on Research and the Society through this Committee. As soon as the methods of analysis have been worked out and approved, the Committee on Research, in cooperation with other bodies, expects to make a comprehensive analysis of similar data from over 100 other stations in the United States.

The Committee on Instruments held a luncheon meeting on Tuesday under the chairmanship of C. M. Ashley, Syracuse, N. Y., and made satisfactory progress on some of the important questions of instrumentation which are of such vital interest in almost every research project.

The Committee on Sound Control, R. D. Madison, Buffalo, N. Y., chairman, met and discussed, among other matters, the sound energy studies on which a start has just been made at the Research Laboratory.

Industrial Exhaust Ventilation in Industrial Hygiene

By Allen D. Brandt,* Chicago, Ill.

SUMMARY — The average worker, when considered as a group, shows no ill effects when exposed to atmospheric contaminants, dusts, fumes, mists, and gases, below the maximum allowable concentration. Local exhaust ventilation is best suited for specific and major sources of contamination while general ventilation is best suited for scattered and minor sources.

The designer of exhaust ventilation systems should have a good knowledge of the fundamentals of air flow into suction openings and should know how contaminants are released and how they react. In general, there are four main types of local exhaust hoods and for each the entering air flow is different.

With the information available today there is little excuse for the existence of atmospheric contamination of such order that the health of the workers is affected adversely.

One of the more important phases of industrial hygiene, if not the most important, is atmospheric sanitation. The air, like water, milk, foods, etc., must be relatively free of harmful contaminants if the health of the individuals breathing the air is to be maintained at a high level. Even though most air borne contaminants (dusts, fumes, mists, smokes and gases) are toxic to a greater or lesser extent, a certain amount of atmospheric contamination is permissible without affecting adversely the health of the exposed individuals.

The permissible amount of contamination varies from individual to individual and from substance to substance, but for a given substance the health of the average individual (considered as a group) is not affected adversely by breathing air containing a given amount of the contaminant.[1,2] For some materials the safe amounts have been determined rather accurately and for other substances a tentative value has been established on the basis of comparable chemical structure, comparable physiological reaction, or field experience. These safe limits are called maximum allowable concentrations and are usually referred to merely as M.A.C. The M.A.C. of a given substance might be defined as the atmospheric concentration of the substance which will have no measurable deleterious effect upon the average individual who breathes the contaminated air eight hours daily. This does not mean that no workers exposed to atmospheric contaminants in the range of the maximum allowable concentrations will show ill effects. Some individuals display unusual susceptibility to certain substances and will show signs of illness even if they work in atmospheres which are not contaminated in excess of the maximum allowable concentration. In general, however, if the atmospheric contamination in industry does not exceed the maximum allowable concentration for the substance or substances in question, the large majority of the exposed workers will show no demonstrable ill effects.

The maximum allowable concentrations vary tremendously from substance to substance. The units in which these concentrations are expressed vary also from substance to substance but, in general, are similar for similar types of substances or types of physiological reactions. Thus the M.A.C. for hydrogen sulfide is 20 ppm; for gasoline 1000 ppm; for lead the M.A.C. is 0.15 mg/m^3, and for TNT it is 1.5 mg/m^3.

Experience in a number of industries has shown that (1) occupational illnesses of a respiratory or systemic nature are rare if workers are not exposed to atmospheric contamination in excess of the maximum allowable concentration; (2) the incidence of occupational illness increases rapidly if workers are exposed to excessive amounts of atmospheric contamination; and (3) the atmospheric contamination can be kept below harmful limits by engineering measures.

Atmospheric contamination in industry is more common than most people realize. Many persons feel that so long as the air is not visibly contaminated or does not cause irritation to the nose and throat, it is respirable, that is, safe to breathe. Consequently, they feel that only relatively few operations or processes are of concern from the point of view of atmospheric contamination. This is, of course, erroneous, for the air may appear perfectly clean and may be wholly free from any irritating action even though it is contaminated greatly in excess of the maximum allowable concentration. It must be remembered that wherever materials are being processed, whether changing the physical or chemical state or the physical size, some of the material will escape into the workroom air in the form of dusts, fumes, mists or gases, except where the operations or processes are conducted in air tight systems or in closed systems maintained under negative pressure. Therefore, consideration must be given by engineers to the problem of atmospheric contamination by most processes and at most operations rather than those few operations or processes which produce visible contamination.

The measures commonly employed for the prevention of excessive atmospheric contamination in industry are as follows:

1. **Control of the dust, fume, mist, smoke, or gas at the point of generation or dissemination. *a.* Local exhaust ventilation; *b.* Enclosures; *c.* Wet methods; *d.* Good housekeeping.**
2. **General ventilation.**
3. **Isolation or segregation of the operations producing atmospheric contamination.**
4. **Substitution of less toxic materials for the toxic ones or of less ob-**

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[1]Superior numerals refer to Bibliography.

Presented at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Grand Rapids, June 1944.

jectionable operations for the ones producing much contamination.

Of these measures, local exhaust ventilation and general ventilation are by far the most important. Consequently, atmospheric sanitation falls largely within the purview of ventilating engineers, and most of this paper will be devoted to a discussion of some of the primary factors involved in the design of adequate, efficient, and economical industrial exhaust ventilation systems.

Local Exhaust Ventilation

Local exhaust ventilation, sometimes referred to by industrial ventilating engineers as process ventilation, is usually employed to control the dust, fumes, gases, or mists at specific and major sources of contamination, whereas general ventilation is applicable to areas having scattered minor sources of contamination. General ventilation is unsatisfactory for the control of important sources of contamination, particularly if workers are nearby, since the ventilation rate must be enormous to result in adequate dilution of the contaminated air between the source of contamination and the worker's breathing zone.

A local exhaust ventilation system usually consists of four main parts—hoods or enclosures, ducts, exhauster, and collector or collectors. Of these, the hood is probably the most vital. It is the purpose of the hood to enclose or partially enclose the source of contamination or to produce air movement at the source of contamination of suitable magnitude and acting in the proper direction to capture the escaping contaminants and convey them into the exhaust system. A thorough knowledge of the laws of air flow into suction openings and of the way in which the various contaminants react is essential to the design of an efficient hood.

While the design of a good hood involves many considerations, the following specific rules should be kept in mind at all times: (1) Enclose the source of contamination as much as possible, (2) locate the hood in line with the natural direction of movement of the contaminant or contaminated air, (3) locate hoods which do not enclose the sources of contamination, as close to the sources as possible, and (4) for hoods which must be located at some distance from the source of contamination, use large hood openings and flanges if possible.

The velocity of air movement at the source of contamination necessary to capture the contaminant may vary from as little as 75 fpm, a velocity sufficient to overcome normal air currents, to as high as 2000 fpm or more, at a high velocity dust producing machine such as a *jack hammer*. Table 1 will serve as a guide in the selection of the proper minimum control velocity for any operation, and shows that the minimum control velocities for the great majority of operations are in the range of 75 to 300 fpm. Even though these velocities will do a satisfactory job if the operation is carried out as intended, and if other adverse influences are prevented, it is very easy to create conditions which will render the local exhaust system ineffective. For instance, any unusual motion in the area of the source of contamination will interfere with the control air currents created by the hood and render the control ineffective. Also opening doors or windows near a local exhaust hood on a moderately windy day will impair the effectiveness of the control. To obtain a clearer picture of the importance of this particular item, namely, that the operation be carried out as intended when the hood was designed and that all adverse influences be avoided, it is only necessary to reflect upon three facts: (1) most minimum control velocities are 300 fpm or less, (2) the average person walks at the rate of about 350 fpm, and (3) the velocity of air movement through open doors and windows on a moderately windy day is in the order of 500 to 1000 fpm. Hence little disturbance is required to upset the control velocity pattern at most operations with the result that some of the contaminant will escape into the general room air. This fact is most important since it is not uncommon to find that open doors and windows near operations provided with local exhaust ventilation render such control measures essentially useless. The fault lies in the design of the plant layout—operations of this nature should not be located near doors and windows. However, with construction completed and the plant in operation, the only solution is in the erection of air barriers and the education of the worker to open doors and windows judiciously. In small rooms or bays where all operations must of necessity be located near the doors or windows, the education of the workers in the proper performance of the operation and the wise regulation of doors and windows is essential.

To obtain the velocities cited in Table 1 for different types of operations, it is necessary to know what quantity of air must be exhausted through the hood. Here again the individual circumstances must be taken into consideration but the following four equations with minor changes will serve to cover all types of operations:

For hoods which partially or wholly enclose the source of contamination[3],

$$Q = VA \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where Q = quantity of air to be exhausted in cubic feet per minute.

V = recommended minimum control velocity in feet per minute (see Table 1)

A = total area of all openings into the enclosure through which the air enters.

Examples are laboratory hoods, spray booths, abrasive blasting cab-

Table 1—Minimum Air Velocities Recommended for the Capture of Dusts, Fumes, Mists, Gases and Vapors Released in Certain Manufacturing Processes

CONDITIONS OF GENERATION OF CONTAMINANT	RECOMMENDED MINIMUM VELOCITY (FEET PER MINUTE)	EXAMPLES OF PROCESSES
Released without noticeable air movement	75-100	Evaporation or escape of liquids from open vessels such as degreasing, pickling, or plating tanks; manual handling of small amounts of dry materials.
Released with low air velocity	100-200	Spray paint booths, cabinets and rooms; dumping dry materials into hoppers; welding.
Active generation	200-500	Some spray painting operations in small booths and with high pressures; active barrel filling; loading conveyors.
Released with great force	500-2000 and higher	Grinding; abrasive blasting.

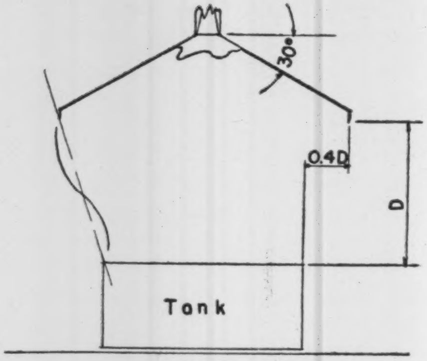


Fig. 1—Canopy hood

inets, chemical reactors, and enclosures around pots or kettles containing toxic materials which are escaping into the air, such as molten lead.

It is apparent from the foregoing equation that the area of the openings into the hood should be as small as is consistent with satisfactory performance of the operation so that the volume of air required is kept at a minimum. It has been our experience that existing installations (particularly spray paint booths) which do not afford adequate control because of low control velocities may often be made adequate by decreasing the area of the opening without interfering significantly with the performance of the operation.

For canopy hoods located above tanks, tables and the like[3],—

$$Q = 1.4\ VPD \quad \ldots\ldots\ldots\ldots (2)$$

Where Q and V are the same as in Equation 1.

P = hood face perimeter in feet.

D = distance in feet from the hood face to the table or tank top.

Examples are the hoods over steam tables, cooking kettles, and immersion tanks.

To obtain good results, the edges of the hood should extend beyond the edges of the tank or table as shown in Fig. 1. It is essential that operations requiring canopy type hoods be located away from doors and windows since extraneous air currents influence the control air currents very readily owing to the relatively large open area between the top of the table or tank and the bottom of the hood.

Even though there are many sources of atmospheric contamination which may be controlled adequately by means of canopy type hoods, they are not as common today as they were years ago. An important disadvantage of, and objection to, canopy hoods at many operations is that the contaminated air is moved through the breathing zone of the worker and consequently does not protect the worker at the operation even though the contaminant is prevented from escaping into the general workroom air. Canopy hoods are being replaced to a great extent by slot type lateral exhaust hoods, and by down draft ventilation.

For slot type exhaust hoods such as are used at the upper edges of tanks, vats, tubs, tables, etc.(4, 5, 6)

$$Q = 2.8\ VLW \quad \ldots\ldots\ldots (3)$$

Where Q and V are the same as in Equation 1.

L and W = tank length and width respectively in feet.

The value of 2.8 does not apply to all conditions but may vary from about 2.0 to 3.5, as will be discussed later. Furthermore, determining a satisfactory control velocity for operations such as degreasing or electro-plating in tanks having a hood along only one long side of the tank is difficult, since to obtain the minimum control velocity at the far edge of the tank requires an unnecessarily large ventilation rate and frequently an excessive rate of solvent loss. There is much evidence available to indicate that for degreasers $Q = 50LW$ and for electro-plating tanks $Q = 120LW$ provides adequate control of the operations.[7,8,9] The respective minimum control velocities are about 18 and 43 fpm, which are too low to be of much significance. The reason for the satisfactory results is, of course, that the velocity is much higher over most of the tank and that the mist or vapor that does escape from the far side of the tank is not sufficient to contaminate the nearby air excessively.

Whenever slot type hoods are used on tanks, table tops, and the like, they should be located at least on both long sides of the tank and preferably along the entire perimeter. Even with the same total ventilation rate, better control is accomplished since a higher velocity is maintained at the tank edge, where interference from extraneous air currents created by movement of nearby workers is the greatest.

For unrestricted hoods at a short distance from the contamination[3],

$$Q = V\ (10x^2 + a) \quad \ldots\ldots (4)$$

Where Q and V are the same as in 1.

x = distance in feet from the face of the hood to the source of contamination.

a = area of the hood opening in square feet.

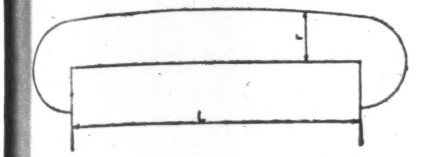
Examples are the hoods frequently used at welding, granite cutting, grinding, and similar operations. This equation is accurate only for free flow into an open hood. If the hood lies on a large flat surface the air flow is cut off from one side of the hood and the value of Q may be decreased as much as one-third for very favorable conditions. Likewise if substantial flanges are used around the hood opening, the velocity contours will be elongated considerably directly in front of the hood and the value of Q may be decreased from 10 to 20 per cent. On the other hand, if there is some obstruction between the source of contamination and the face of the hood, the value of Q must be increased accordingly.

Tables or work benches with down draft grille tops constitute a different type of hood. An analysis of the problem will reveal, however, that such hoods fall into group 1 or group 4, depending upon whether the contaminant is released directly at the grille or at some distance above it. If released directly at the grille the value of x in Equation 4 becomes zero and the resulting equation is $Q = Va$, which is identical with that in Equation 1.

To paint a better picture of the fundamental laws governing the characteristics of air flow into suction openings it may be well to see how these equations fit the basic physical laws of the flow of fluids.

The first equation is obviously the fundamental law for the flow of fluids and needs no further breakdown.

To better understand the second equation, reference should be made to Fig. 1. All the air removed by the hood must pass through the area between the lower edges of the hood and the upper edges of the tank, that is, $A = PD$ (approximately). Consequently, $Q = PDV$. However, the average velocity through this opening is considerably higher than the control velocity at the tank top. A factor is needed to have the equation apply at the source of contamination and it was found by Dalla Valle that



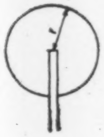


Fig. 2—Slot type hood

for the usual design of tanks and canopy hoods the velocity at the upper edge of the tank is only 70 per cent of the average velocity through the open area between the tank top and the lower edges of the hood[3], hence $Q = 1.4\ PDV$.

To break down the third equation it is necessary to visualize a slot type exhaust hood as a modification of a theoretical line source of suction of considerable length, as shown in Fig. 2. Under these conditions the velocity contours in a plane perpendicular to the source of suction, obviously, would be concentric circles with the center at the point of intersection of the plane with the line. The area through which air is moved at a given velocity by the line source of suction is essentially that of a cylinder, hence $Q = AV$ becomes $Q = 2\pi rLV$ or $6.28\ rLV$. It has been found by experiment that the velocity contours in a plane perpendicular to a slot type exhaust hood are essentially circular in shape but are elongated slightly directly in front of the hood opening and are flattened at the sides of the hood[4] (see Fig. 3). Furthermore, with slot type exhaust hoods on tanks, tables, and the like, a considerable portion of the cylindrical surface through which the air might enter the hood is cut off so that the constant is decreased considerably and has been found[4] to be in the order of 2.8 (a value of 2.3 was reported by Silverman[5]). Consequently, since the radius of the contour is the width of the tank, $Q = 2.8\ WLV$.

To better understand the Equation 4 type of hoods it is necessary to visualize the nature of air flow into a theoretical point source of suction as indicated in left part of Fig. 4. The equal velocity surfaces would be spheres and the equation of air flow would be $Q = 4\pi r^2 V$ or $Q = 12.57\ r^2 V$. However, the contours are elongated in front of a freely suspended hood and are affected by the size of the opening (see Fig. 4, illustration at right). As a result, the constant is decreased somewhat and the hood area must be taken into consideration. Dalla Valle found that the value of the constant is 10 and that the correct equation is $Q = V(10x^2 + a)$ (the radius r of the approximate sphere is the same as x, the distance from the hood face to the source of contamination).

It is necessary that the foregoing fundamentals of air flow into suction openings be understood thoroughly if the engineer is to be able to design local exhaust ventilation systems which will control the contaminant effectively and economically. A much too large percentage of the installations seen by us either do not control the contaminant effectively or are so completely over designed that they are wasteful of power and present unnecessary heating problems.

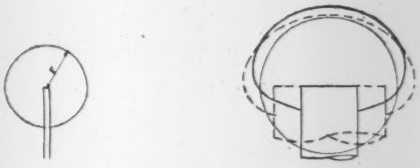


Fig. 4—Freely suspended hood

The ducts should be designed almost entirely on the basis of transporting velocity which varies from about 1500 to 5000 fpm, depending upon the nature of the contaminant. As a rule, the system should be so designed that it will be balanced, eliminating the need for adjustable dampers in some branch ducts. Such dampers are a constant source of trouble. Long radius bends are desirable and branch to main duct connections should have an included angle of less than 30 deg.

Collectors are not always needed in local exhaust ventilation systems. If the contaminant is of no value, does not present a nuisance if discharged into the atmosphere, and does not present a fire, explosion, abrasion, or corrosion problem in the ducts or fan, collectors are not necessary. As a rule, collectors should be located upstream from the fan and it is sometimes advisable to have them located as close to the hood as possible for reasons of fire and explosive safety. In the explosives manufacturing and processing plants, for example, most of the local exhaust ventilation systems which have been installed in the last year have an industrial collector of the wet type

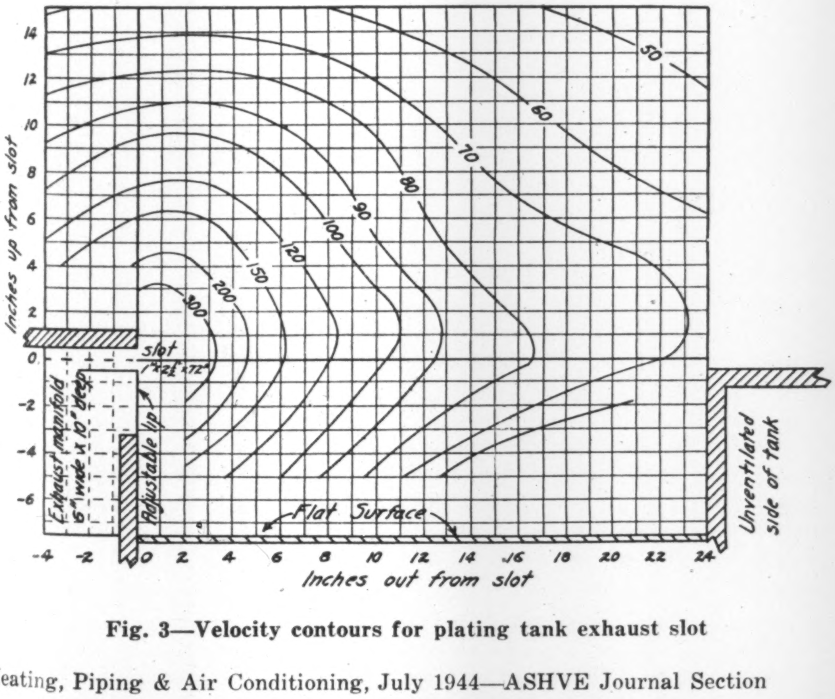


Fig. 3—Velocity contours for plating tank exhaust slot

located adjacent to, or as close as possible to, each hood so that the explosive contaminant is not conveyed through considerable duct work. Also particular attention is paid to the location of a wet collector in each branch duct so that in the event of a fire or explosion at one operation it will not propagate to other operations.

Exhausters are usually centrifugal type fans, or ejectors. Propeller type fans are sometimes used if the resistance of the system is very low. For most operations centrifugal fans are preferred since ejectors, whether air, steam or water operated, are inherently very inefficient. However, where the contaminant is flammable, explosive, or unusually corrosive, ejectors are used frequently. A fair percentage of the exhausters in the local exhaust ventilation systems in the Army explosives manufacturing and processing industries are air or steam operated ejectors since most of the contaminants transported through these systems are highly flammable and explosive.

General Ventilation

As stated previously, general ventilation is satisfactory for the prevention of excessive atmospheric contamination in rooms or buildings housing operations or processes which present minor and scattered sources of contamination. Control of excessive contamination is accomplished by introducing sufficient uncontaminated air to dilute the contaminant to a level below the maximum allowable concentration. The volume of air needed can frequently not be determined with any degree of accuracy. However, a fair estimate of the increase in ventilation needed to control excessive contamination in a given room or building may be made by determining the degree of atmospheric contamination, and estimating the existing ventilation rate. From these values the additional volume of air needed can be computed readily.

In rooms or buildings where operations are conducted involving, for example, the use of a solvent, the quantity of solvent used daily may be ascertained from the stock room records or other records which indicate the rate of consumption. With this information available, the ventilation rate in cubic feet per minute may be computed[10] by means of the equation, $Q = \frac{X}{M}$, where X is the quantity of toxic substance released in cubic feet per minute and M is the maximum allowable concentration of the contaminant per cubic foot of air. For example, if a gallon of carbon tetrachloride (M.A.C. 100 ppm) is used every 8 hour shift for miscellaneous cleaning purposes in a room of a building, the ventilation rate required to prevent the room air from becoming contaminated in excess of the maximum allowable concentration is determined as follows:

$$X = \frac{(\text{cc/gal})\quad(\text{sp. gr.})\quad(\text{mol vol})}{(\text{mol wt})\quad(\text{liters/cu ft})} = \frac{3785 \times 1.58 \times 24.4}{154 \times 28.3} = 33.5 \text{ cu ft}$$

$$M = 100 \text{ ppm} = 0.0001 \text{ cu ft vapor/cu ft of air}$$

$$\text{Hence } Q = \frac{33.5}{0.0001} = 335000 \text{ cu ft/8 hrs} = 698 \text{ cfm}$$

It may be well to point out that the important factor in general ventilation is the ventilation rate in terms of cubic feet per minute and not air changes per hour. This fact is not commonly recognized and engineers are frequently heard to express the thought that the recommended ventilation rates in cubic feet per minute are too high because *that will be over* 20 *air changes per hour*. The rate of air change means little unless the size of the room is taken into consideration. For instance, with good air distribution and all other things being equal, 10 air changes per hour in a room of a given size will result in the same degree of contaminant control as 30 air changes per hour in a room having one-third its cubical content.

Industrial Ventilation in Army Plants

In the Army explosives manufacturing and processing plants we encountered some problems which are unique in industry and which presented new problems.[11] The size, location, and distribution of the buildings presented an extraneous air movement problem. The nature of the contaminant and operations presented a serious fire and explosion hazard. The nature of the industry presented an important economic problem, that is, the frequent changes in operations and anticipated short life of the industry dictated in favor of low first cost even at high operating and maintenance costs.

The problems were solved by using ventilation only where absolutely necessary and preventing excessive exposure to workers by enclosing the operations as much as possible, rotating workers, and using respirators at operations presenting intermittent exposures. Nevertheless, a large number of local exhaust ventilation systems were found necessary. The systems installed may be grouped into three general classifications, all of which have been found satisfactory from both the health and safety viewpoints. These groups are as follows: (1) Unit systems with an industrial wet collector located adjacent to, or as close as possible to, each hood. (2) Unit systems with all ductwork sloping downgrade toward a sump located outside the building, and with sufficient water sprays located throughout the ducts to keep all interior surfaces of the ducts and fan wet at all times. The fan is located downstream but upgrade from the sump so that most of the water does not pass through the fan but is drained into the sump by means of a Y in the duct at the sump. (3) Single duct systems with or without filters, and employing ejectors as exhausters.

Additional detail on these installations will not be given here but may be found in references at end of paper.[11, 12, 13] However, a few of the results obtained will be mentioned to indicate the excellent improvement in atmospheric sanitation which has been accomplished. At mechanical screening or sieving operations where the workers' exposures to atmospheric dust both at the charging and discharging stations were of the order of 10 to 60 times the maximum allowable concentration without adequate control, the exposures were reduced to about one-third of the M.A.C. with local exhaust ventilation systems designed by our engineers. At a cupping operation, a reduction from two to 10 times the recommended maximum level to only a trace was effected. At a production box filling operation, the exposure was reduced from a level of two to four times the maximum allowable concentration to about one-third of this value.

It has been our experience that respirable air can generally be maintained economically at most operations in industry by the use of carefully planned exhaust ventilation systems. There is little excuse from the public health engineering viewpoint for the continued existence of air in industry which is contaminated sufficiently to be a health hazard to workers.

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C. M. H. KAERCHER DIES

Carl M. H. Kaercher, widely known engineer and manager of the Central Bureau for Heating and Air Conditioning, Cleveland, Ohio, died at his home in University Heights, June 12, at the age of 51.

Mr. Kaercher was born on February 15, 1893, at Cleveland, where he prepared at Glenville High School. He received his B.S. in electrical engineering from Case School of Applied Science in 1913. While at Case he was a member of Tau Beta Pi and the honorary engineering fraternity Eta Kappa Nu.

Following his graduation he worked for a time for the Ohio Bell Telephone Co., then served as Secretary and Engineer in charge of installation for the Scientific Heater Co., Cleveland, also four years as heating engineer for The Forest City Foundries Co.

In recent years he had been Consulting Engineer for the City of Shaker Heights and of the engineering firm of MacGeorge and Hargett, in addition to directing his own heating and air conditioning organization.

Mr. Kaercher was twice Secretary-Treasurer and also President of the Northern Ohio Chapter of the ASHVE, since joining in 1936.

He is survived by his widow, the former Edna Goodaire, and two sons, Edwin B. and Ralph W. A brother, Gustav, and three sisters, Mrs. Amanda Bucher, Candlewood, Conn., Mrs. Emily Pierce of Detroit, and Mrs. Rosina Kuenhold of Cleveland, also survive.

Services were held at the funeral home of Charles Melbourne and Sons in East Cleveland, on June 13.

The Officers and Council of the Society extend their sincere and heartfelt sympathy to his family in their bereavement.

BERNHARD BREDESEN DIES

Bernhard Palmer Bredesen, born in Minneapolis on February 14, 1894, died on March 15, 1944, according to word just received.

Mr. Bredesen received his early education in Minneapolis and his first position was with the Engineering Department of the Northwestern Supply Co., Minneapolis. In 1922 he was employed as Branch Manager of Sales and Engineering at the National Heating and Ventilating Co., and after seven years in that capacity he went with the Herman Nelson Corp. as Sales Engineer. In 1939 he became Engineer for the firm of Reese and Bredesen with offices in the Essex Bldg., Minneapolis.

The Officers and Council of the ASHVE extend their deepest sympathy to his widow for the great loss she has sustained.

O. E. GOLDSCHMIDT DIES IN NEW YORK

Otto E. Goldschmidt, consulting engineer and recently used machinery and equipment specialist for the War Production Board in New York, died June 29 at French Hospital following an operation.

Prior to his affiliation with the WPB he had a consulting engineering office in New York and held membership in the Society for 24 years.

He was graduated from the University of Illinois with a degree in mechanical engineering in 1894. In 1910 he set up his office in New York, where he specialized in designing and supervising heating and ventilating systems, electric wiring installations, power plant equipment, plumbing and drainage work for industrial plants, hotels and office buildings.

In 1937 he retired as consulting engineer, and in 1942 was prompted to do his bit toward the war effort, and joined the War Production Board.

He is survived by his widow, Mrs. Lillian Lent Goldschmidt, and a brother, Edward L. Goldschmidt, to whom the Officers and Council of the American Society of Heating and Ventilating Engineers extend their deepest sympathy.

A Method of Heating a Corrugated Iron Coal Preparation Plant

By E. K. Campbell,* Kansas City, Mo.

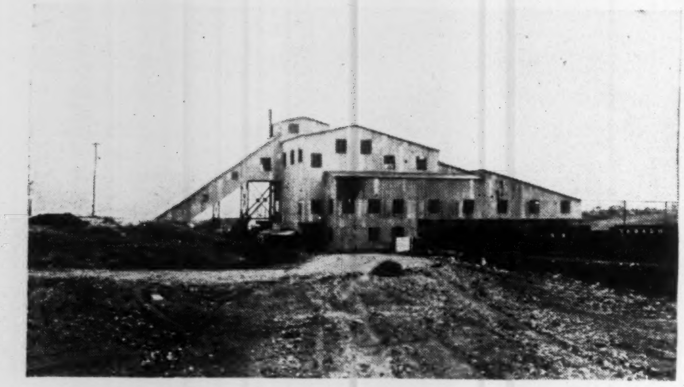

Fig. 1—Coal tipple for strip mine

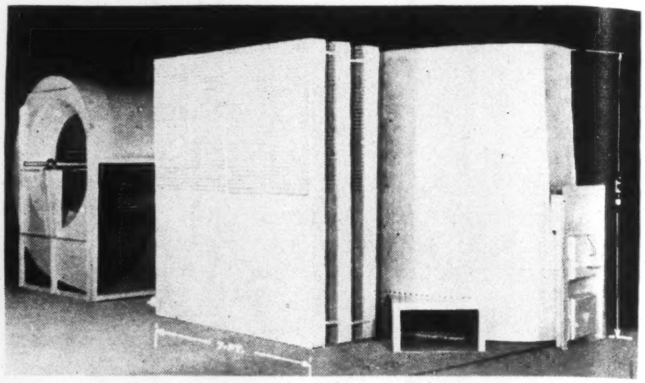

Fig. 2—Fan furnace before installation

SUMMARY—A description of a heavy duty fan furnace installation presenting a difficult heating problem which was solved by application of allowances based upon experience.

The results obtained proved the validity of the assumptions made in estimating the size of equipment required.

THE PROBLEMS involved in heating a coal tipple and coal washing plant built of corrugated iron are so unusual that perhaps a description of a more or less experimental plant may be of interest. It is experimental because there is no way of measuring or guessing intelligently some factors of the problem, but it is a plant intended and guaranteed to meet the problems to the extent that there should be no freezing of pumps and pipes, a prolific source of trouble in corrugated iron coal preparation plants.

Fig. 1 shows a view of the tipple with the main elevator from the dump pits on the left, and the extension of the building over the tracks on the right, where an uninsulated steel floor is perforated for the car loading chutes, which must be kept open for inspection.

The coal preparation plant belongs to a coal company of Kansas City, which operates strip coal mines in a number of different locations. The experience of the company has shown that a considerable area of coal bearing land can be stripped and the coal exhausted in a comparatively short period. This semi-temporary character of the strip mine makes it necessary at intervals to move the entire plant in order to avoid too long hauls from the shovel to the tipple. This was the immediate occasion of the building of this particular tipple. It was formerly located 14 miles to the south, but that field became exhausted. It was moved to its present location and enlarged in capacity in opening a new field.

Because of this necessity for occasional moving, the owners have standardized on corrugated iron buildings with steel frames, thereby making it possible to so design and construct the buildings that they can be taken down, a section at a time, and very quickly moved and re-erected in another location. This construction, of course, creates many problems for the engineer who undertakes to provide heating equipment. Any attempt to heat the building as such, as distinguished from spot heating, must be more or less experimental and dependent on making the building tighter than usual for most of these galvanized buildings.

Hence, any attempt to estimate the heat load involves a very large element of guessing. In this particular case, the area of the corrugated iron and steel surface was estimated and doubled, and proper factors were applied for a 60 deg temperature rise, to obtain an inside temperature of 40 F at —20 F outside, and to arrive at a heat load of about 3,600,000 Btu.

It is the practice of the author to arrive at a value for air leakage by using a percentage of the heat transmission loss. This has been found to be a highly satisfactory method. In ordinary churches, schools, theaters, and buildings without too many openings, the leakage is estimated at 20 per cent of the building heat transmission loss, but in church vestibules and similar places where the openings are large and much used in propor-

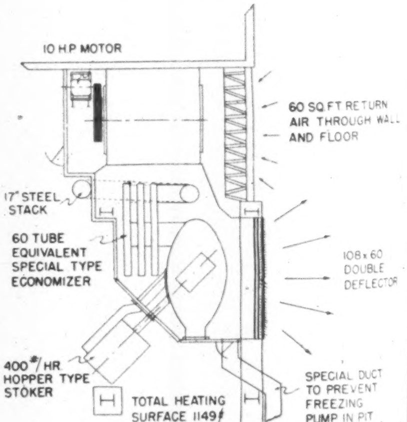
10 H.P MOTOR
60 SQ.FT RETURN AIR THROUGH WALL AND FLOOR
17" STEEL STACK
60 TUBE EQUIVALENT SPECIAL TYPE ECONOMIZER
108 x 60 DOUBLE DEFLECTOR
400#/HR HOPPER TYPE STOKER
TOTAL HEATING SURFACE 1149#
SPECIAL DUCT TO PREVENT FREEZING PUMP IN PIT

Fig. 3—Location of heating equipment

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*President, E. K. Campbell Heating Co. Member of ASHVE.

Presented at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Grand Rapids, June, 1944.

tion to the size of the space, the leakage may be equivalent to 100 per cent of the building heat loss. The method provides easy means of checking actual results against the estimated load, but cannot be successfully applied without judgment, backed by experience. Checking the estimated load in the Butler Field house, which was a tight building with an insulated roof, against the test results, proved that 20 per cent allowance for leakage was substantially correct.

Leakage is the unpredictable item in a corrugated iron building of the type described. The necessary height of the building, in order to provide the fall for the coal screens, etc., produces a heavy chimney effect. The construction necessarily leaves many holes. Where a corrugated sheet is bolted to an angle, there is a hole the size and shape of the corrugation every 2½ in. around the entire building, both top and bottom. Where loading chutes pass through the steel floor or the sidewall of the track extension, the chutes themselves form tubes which admit cold air to the building. Effective ways of closing them are difficult to devise. Also, there is an inspection opening in the chutes just above the steel floor that is open a good deal of the time. In this particular case, there is a large water settling cone in which the water is reclaimed and sludge drained off by the settling process. The bottom of this cone is enclosed in a housing, but the top is exposed and few precautions are taken to make it tight where the housing fits around the cone. Also, an additional part of the load is that required to keep the water in the cone from freezing and this is accomplished by the simple fact that its lower half is housed inside the building. There are various other openings and holes through which air can pass. It is difficult for a person to realize without an inspection how open these buildings are. It is equally difficult to arrive at a conclusion as to how much to figure for the infiltration load. In this case, arriving at the infiltration load was purely guess, and it was guessed at 100 per cent of the measurable quantities.

Based upon the foregoing esti-

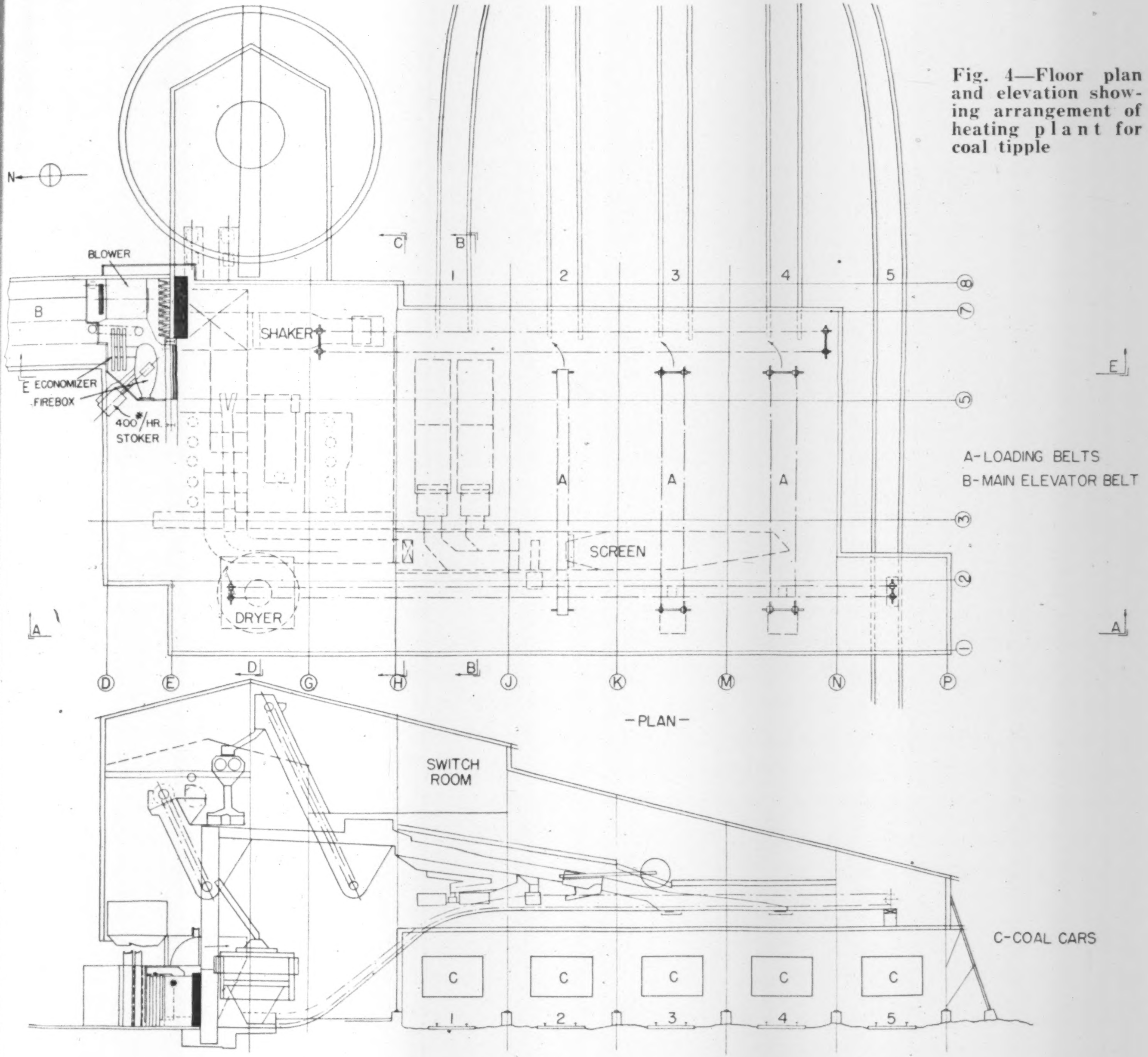

Fig. 4—Floor plan and elevation showing arrangement of heating plant for coal tipple

mated information, a furnace rated to deliver 4,000,000 Btu per hour was selected. The basis of the rating was that given in the Heating, Ventilating, Air Conditioning Guide, limiting the rating to 3500 Btu per square foot of surface. Fig. 2 shows a shop photograph of the furnace containing 1145 sq ft of heating surface. It was equipped with a special type of economizer designed to fit the limited space available for the location of the plant. The ratio of grate area to heating surface, if grates were provided for a furnace of this size, would be about 1 sq ft of grate area to 47 sq ft of heating surface. This ratio, combined with the low temperature air being driven over the heating surface, would result in a very high efficiency, and should compare with the test results on the Butler Field House, where under somewhat similar conditions of large volumes of air handled, efficiency was shown at 89.4 per cent.

The furnace was equipped with a 400 lb stoker which, together with the efficiency of the furnace and the type of coal to be used, could reasonably be expected to produce a 4,000,000 Btu output.

The blower had a 54 in. x 54 in. wheel, was equipped with a 10 hp motor driving the fan at about 160 rpm, and delivered approximately 47,000 cfm. This would handle the volumetric contents of the building about every 7 min, and it would result in a temperature rise of the air as it passed over the furnace at about 80 deg, which was about as low as would be feasible under the extreme conditions of a building of this character.

Fig. 3 shows a floor plan of the heating equipment and Fig. 4 is a floor plan and elevation of the building and the location of the plant with relation to the building. It will be noticed that the heat was all discharged at one place, and the return air all brought back to one point. There was no short circuiting as the discharged air was free to move away, with considerable velocity, while the return air flowed back on a lower level.

The system was originally designed without any distributing ducts, which would be objectionable for obvious reasons. But when 17 deg below zero weather was encountered one pump froze, due to the fact that it was set in a pit on a lower level than the return air inlet and no provision had been made to draw the air out of the pit. To cure that particular trouble, a special duct was run, discharging its heat downward immediately over the pump, thereby combining spot heating with the attempt to heat the space as a whole.

Also, on account of the excessive leakage, the temperature differential between the bottom and top of the tipple was quite high. At 17 deg below zero outside, the temperature was in the neighborhood of 65 F in the upper part of the tipple, and down on the level of the return air, approximately 40 F. The cure for this condition would consist not in increasing either the amount of heat or the volume of air, but in making the building tighter to prevent the excessive infiltration of large volumes of below zero air.

The net result of this experimental installation with the adjustments that have been made and with some tightening up still to be done, is satisfactory to the owners, because it enables them to get away from troubles which they had experienced before when using spot heating with steam and with unit heaters. They were not interested in fuel economy. They built a conveyor which takes the coal right from the washer and dumps it into the hopper of the stoker. They were interested in eliminating freezing of pipes, pumps, etc., and getting rid of the action of sulphur water which prevails around so many mines. As a part of the portable building, this plant can be picked up with proportionately as little trouble as the balance of the building and reset in another location. For these reasons, the purchasers feel that the experiment has been a success.

Discussion

W. H. Carrier, Syracuse, N. Y.: The author had a very difficult job, but has done an excellent job of *guesstimating*. In the early state of the art of calculating, as I knew it in 1901 and 1902, warm air heating for all buildings had to be *guesstimated*. My first experience was with the Buffalo Forge Co. in 1901, when I went into the estimating department. The volume of air to be handled by the fans to heat a building was estimated to produce one air change in from 50 min for good construction to 15 min for poor construction. A 20 min air change was found to be a very satisfactory average value.

Nobody knew how much steam was condensed, what effect the air velocity had on coil heat output, or what the pipe spacing should be. The procedure for selecting coils was to select the rate of air change and then vary the number of rows of heaters according to the geographical location and using for instance: five rows for New York, six for Canada, and four for the South. It was surprising how many jobs worked.

To correct the above unscientific method the first move was to determine heater performance and then to determine what to do with it. The heat transmission through walls could be calculated, but the leakage of air was an unknown factor.

In 1902, with another engineer, I spent the winter testing buildings to develop a method of determining leakage. Air leakages on the basis of calculation in well constructed buildings were found to be as low as one change in four hours, which was quite astonishing, and in others, one change in two or in one-and-a-half hours, but none in less than one hour. Therefore one air change per hour was used until a method based on surface was adopted.

Air leakage, as was determined later, is proportioned to surface rather than building volume.

When solving a problem such as that described by the author, it still is necessary to go back to the old method of *guesstimating*.

C. M. Ashley, Syracuse, N. Y.: Our Society has two infiltration research programs: one on techniques of measurement, which certainly need improvement, and one on infiltration through doors, etc., a subject about which little is known.

B. B. Reilly, Pittsburgh, Pa.: Was comfort the only basis for design and, if so, didn't 4,000,000 Btu seem like a tremendous amount of heat for the normal occupancy of a half-dozen people?

Author's Closure: If the comfort of the employees had been the principal consideration, it would have been a lot of heat. The main object was to prevent shutdowns due to freezing—the bane of tipple operation in these large coal-washing plants at strip mines. The shovels pick up a lot of mud along with the coal and the only way to make the coal marketable is to wash out the mud. Freezing would interrupt the operation of the tipple.

The remarks made by Dr. Carrier indicate that, while we do like to have things scientifically accurate and are making great progress in that direction, the contracting engineer particularly is bound to come face to face with problems in which he has to base his design on general experience and sometimes on thumb rules.

Selecting Winter Design Temperatures

By Paul D. Close,* Chicago, Ill.

THERE APPEARS to be no universally accepted rule for selecting winter design temperatures. Obviously the design temperatures should be low enough to provide for all reasonably severe conditions but not necessarily for the lowest temperatures likely to be encountered which may be of short duration, and rarely, if ever, repeated. Such low temperature valleys can generally be bridged over by the heat capacity or fly-wheel effect of the structure. It is of course a simple matter to *play safe* by selecting a design temperature well below that likely to be encountered in the locality of the building. A heating plant designed on this basis would of course be ample, but it would also be more than ample, that is, it would be over-sized. Therefore, the problem is to select a temperature sufficiently low, but yet not too low.

While there is certainly no objection to providing a reasonable reserve or factor of safety in selecting a heating plant, it would seem that some rational or uniform basis for establishing the proper design temperature for each locality would be desirable. It is, of course, recognized that wind velocities must also be considered where the infiltration losses are determined by the crack method, but the present discussion is concerned only with design temperatures.

One rule which has been used to a considerable extent is to base the design temperature on the lowest temperature ever recorded in the locality, the temperature selected being a specified number of degrees —usually 10 to 15—above this lowest recorded temperature. The principal objection to this method is that such minimum temperatures oftentimes are not *normal* in the sense that they are of short duration or might seldom, if ever, be repeated, thus resulting in inconsistent design temperatures.

Whatever method or rule is used for selecting winter design temperatures, it must necessarily be more or less arbitrary, since the rule must be predicated on certain arbitrary assumptions. It would appear that any rule which may be agreed upon must necessarily be approximate because of the nature of the problem. Furthermore, it is also probable that any such rule will involve the usual exceptions and will necessitate adjustments in some cases for local conditions.

In an endeavor to establish some reasonably reliable and consistent formula for selecting winter design temperatures which would eliminate the effect of temporary extremes, a study was made of weather data compiled in various forms by various sources. One particularly helpful and useful compilation of data used in this study was that entitled "An Analysis of Winter Temperatures for One Hundred and Twenty Cities."[1] These data for example, included a tabulation for the various cities of daily *mean* as well as daily *minimum* temperatures. The number of times the various temperatures occurred during a 23-year period (whether mean or minimum) was shown, thus making it possible readily to analyze the temperatures from the standpoint of winter design. Weather Bureau records were also examined and particular attention was given to various *averages* or *normals*.

In many localities, particularly in the larger cities, winter design temperatures have become more or less arbitrarily established through experience, taking cognizance perhaps of weather bureau records. For example, it is common practice to use a temperature of —10 F for Chicago and this design temperature has given satisfactory results over a period of years. Similarly —20 F is generally used for Minneapolis and St. Paul, zero degrees for Washington, D. C., +10 F for Atlanta, Ga., and so on. As a part of this study, the design temperatures generally used in the larger cities were plotted on a map of the United States. The temperatures used were based on data obtained in 1940 from the ASHVE Chapters throughout the United States and included temperatures for cities in each chapter area. While the temperature variations appeared to be more or less consistent with variations in the temperature zones, there were many obvious inconsistencies and although it might be a comparatively simple matter to adjust these obvious inconsistencies, the purpose of this study was to endeavor to find a rule which would not only eliminate inconsistencies but which would be applicable to any locality, bearing in mind that in some of the smaller or more remote communities or urban areas, design temperatures have not been established by practice or experience. It is reasonable to assume

Table 1—Differences Between January Normal Temperatures and Design Temperatures Generally Used in Various United States Cities

City	January Normal†	Design Temperature in General Use‡	Difference
Bismarck, N. D	7.8	—30	37.8
Huron, S. D.	12	—25	37
Minneapolis, Minn.	13.1	—20	33.1
Green Bay, Wis.	15.6	—20	35.6
Pocatello, Idaho	25.7	—10	35.7
Chicago, Ill.	23.9	—10	33.9
Springfield, Ill.	26.9	—10	36.9
Cleveland, Ohio	26.8	—5	31.8
Pittsburgh, Pa.	30.9	—5	35.9
Washington, D. C.	33.9	0	33.9
Oklahoma City, Okla.	37	0	37
Ft. Smith, Ark.	39.2	5	34.2
Birmingham, Ala.	46	10	36
Atlanta, Ga.	43.1	10	33.1
Shreveport, La.	47.2	10	37.2
Savannah, Ga.	51.8	15	36.8
Mobile, Ala.	51.6	20	31.6
New Orleans, La.	54.7	20	34.7
Jacksonville, Fla.	55.6	25	30.6

†From U. S. Weather Bureau.
‡See ASHVE GUIDE 1942, pages 130-131.

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*Technical Secretary, Insulation Board Institute. Member of ASHVE.

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[1] Compiled by Prof. C. M. Humphreys, Carnegie Institute of Technology and assisted by workers furnished by the W.P.A.

Table 2—Design Temperatures for Various United States Cities Based on January Normal Method

A	B	C	D	E
STATE	CITY	JANUARY NORMAL†	JANUARY NORMAL LESS 35 DEG‡	ADJUSTED DESIGN TEMPERATURE (BASED ON COLUMN D)
Ala.	Birmingham	46	11	10
	Mobile	51.6	16.6	15
Ariz.	Flagstaff	27.6	—7.5	—10
	Phoenix	50.9	15.9	20
Ark.	Fort Smith	39.2	4.2	5
	Little Rock	42	7	10
Calif.	Los Angeles	55.1	30.1‡	30
	San Francisco	50	25‡	25
Colo.	Denver	26	—9	—10
	Grand Junction	25.2	—9.8	—10
Conn.	New Haven	28.4	—6.6	—5
D. C.	Washington	33.9	—1.1	0
Fla.	Jacksonville	55.6	20.6	20
Ga.	Atlanta	43.1	8.1	10
	Savannah	51.8	16.8	15
Ida.	Lewiston	32.7	—2.3	0
	Pocatello	25.7	—9.3	—10
Ill.	Chicago	23.9	—11.1	—10
	Springfeld	26.9	—8.1	—10
Ind.	Evansville	36	1	0
	Indianapolis	28.4	—6.6	—10
Iowa	Dubuque	19.0	—16	—15
	Sioux City	19.0	—16	—15
Kan.	Concordia	27.0	—8	—10
	Dodge City	29.3	—5.7	—10
Ky.	Louisville	34.5	—0.5	0
La.	New Orleans	54.7	19.7	20
	Shreveport	47.2	12.2	10
Maine	Eastport	20.7	—14.3	—15
	Portland	22.4	—12.6	—10
Md.	Baltimore	34.3	—0.7	0
Mass.	Boston	28.2	—6.8	—5
Mich.	Alpena	18	—17.0	—15
	Detroit	24.5	—10.5	—10
	Marquette	16.0	—19.0	—20
Minn.	Duluth	9.3	—25.7	—25
	Minneapolis	13.1	—21.9	—20
Miss.	Vicksburg	48	13	15
Mo.	St. Joseph	26.0	—9	—10
	St. Louis	31.8	—3.2	—5
	Springfield	33.2	—1.8	0
Mont.	Billings	22.6	—12.4	—20
	Havre	13	—22	—25
Nebr.	Lincoln	23	—12	—15
	North Platte	23.1	—11.9	—15
Nev.	Tonopah	30.4	—4.6	—5
	Winnemucca	27.9	—7.1	—10
N. H.	Concord	21.2	—13.8	—15
N. J.	Atlantic City	33.2	—1.8	0
N. Y.	Albany	24.0	—11	—10
	Buffalo	24.9	—10.1	—10
	New York City	30.9	—4.1	—5
N. M.	Santa Fe	29.3	—5.7	—5
N. C.	Raleigh	41.7	6.7	10
	Wilmington	47.2	12.2	15
N. D.	Bismarck	7.8	—27.2	—30
	Devils Lake	2.2	—32.8	—30
Ohio	Cleveland	26.8	—8.2	—10
	Columbus	29.1	—5.9	—5
Okla.	Oklahoma City	37.0	2.0	0
Ore.	Baker	24.9	—10.1	—10
	Portland	39.1	14.1‡	15
Penn.	Philadelphia	32.9	—2.1	0
	Pittsburgh	30.9	—4.1	—5
R. I.	Providence	27.7	—7.3	—5
S. C.	Charlotte	50.2	15.2	15
	Columbia	46.5	11.5	10
S. D.	Huron	12.0	—23.0	—25
	Rapid City	22.5	—12.5	—15
Tenn.	Knoxville	38.8	3.8	0
	Memphis	41.3	6.3	5
Texas	El Paso	44.9	9.9	10
	Fort Worth	46.1	11.1	10
	San Antonio	52.6	17.6	15
Utah	Modena	26.8	—8.2	—10
	Salt Lake City	29.2	—5.8	—5
Vt.	Burlington	22.3	—12.7	—15
Va.	Lynchburg	37.4	2.4	5
	Norfolk	41.4	6.4	5
	Richmond	38.2	3.2	5
Wash.	Seattle	39.8	14.8‡	15
	Spokane	26.3	—8.7	—10
W. Va.	Parkersburg	33.0	—2.0	—5
Wis.	Green Bay	15.6	—19.4	—20
	LaCrosse	15.5	—19.5	—20
	Milwaukee	20.5	—14.5	—15
Wyo.	Lander	18.7	—16.3	—20
	Sheridan	18.8	—16.2	—20

†From U. S. Weather Bureau.
‡25 deg deducted on Pacific Coast as indicated.

†From U. S. Weather Bureau.
‡25 deg deducted on Pacific Coast as indicated.

that many of the temperatures now used—perhaps the majority of them—are substantially correct for the respective localities and may be regarded as criteria.

In studying these data it became apparent that the design temperatures now generally used have a more or less fixed relationship to the January normal, except in the case of the obvious inconsistencies. In other words, the design temperature generally used averaged about 35 deg below the January normal, except along the Pacific Coast, where the departure from the January normal averages about 25 deg. This means that the average minimum departure from the January normal for design purposes is 35 deg (except 25 deg on the Pacific Coast). The smaller deviation from the January normal on the Pacific Coast is no doubt due to the equalizing or tempering effect of the Japanese stream.

Table 1 gives the differentials for a few selected cities (other than Pacific Coast) between the January normals and the design temperatures now generally used. It should be noted that the cities listed represent practically the entire range of design temperature zones for the United States, showing that the departure from the January normal is fairly consistent for all zones rather than for just one section. Since design temperatures are generally specified in even 5 deg, a tolerance of plus or minus 5 deg might be allowed in establishing this rule, thus also permitting some adjustment to provide for local conditions.

Table 2 gives the design temperatures for various cities based on a fixed departure from the January normals. In this table the January normals minus 35 deg (25 deg on the Pacific Coast), are given in Column D. The figures in Column D are adjusted up to +5 deg in Column E, the values in this column being the recommended design temperatures for this method. The adjustment was made to the *nearest* 5 deg in most cases, the exception being instances where the opposite adjustment (but within 5 deg) appeared to be justified. In only one city—Billings, Montana—was an adjustment made of more than 5 deg. Fig. 1 is a map of the United

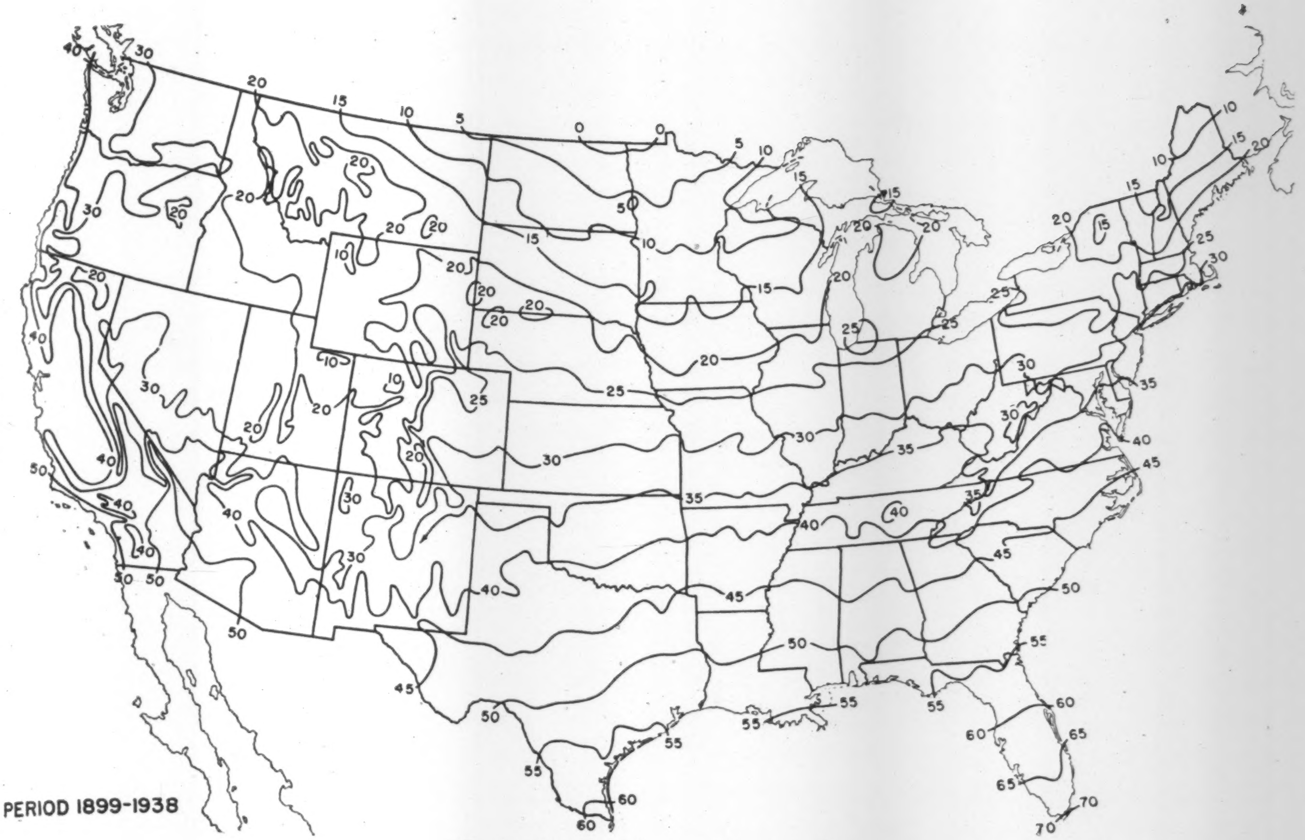

Fig. 1—Average January temperature

States showing average January temperatures as compiled by the Weather Bureau.

Still another basis for selecting winter design temperatures is the average annual minimum temperature. (See Fig. 2.) This of course is the average of the minimum temperatures which have occurred once each winter for the period 1899-1938, as is indicated on Fig. 2. For example, the average minimum temperature in Chicago is —8 F and in New York —3 F. Minor adjustments would be made in most cases either to the nearest or next lowest even 5 deg temperature. The average minimum has the advan-

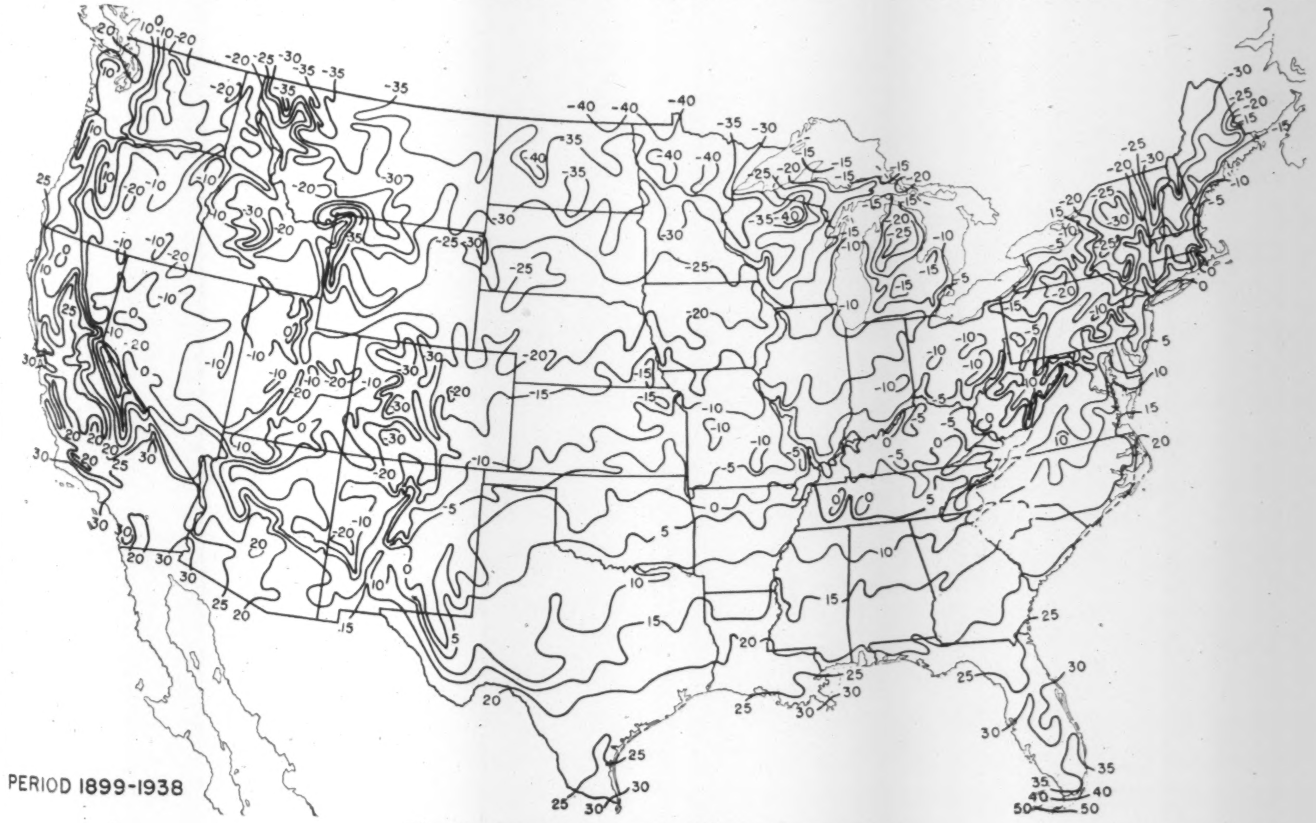

Fig. 2—Average annual minimum temperature

tage that it eliminates the effect of abnormal extremes and it would seem to the author that this is a logical basis for the selection of winter design temperatures.

A comparison of three bases of selecting design temperatures for various United States cities is given in Table 3. Columns C and D show the design temperatures for the lowest recorded temperatures, plus 10 and plus 15 deg respectively. Column E gives the commonly used temperatures for each city—which may not necessarily be regarded as reliable criteria in all cases—and Column F is the recommended design temperatures based on the January normals as per Column E of Table 2. The average annual minimum temperatures are given in Column G.

While averages may have no particular significance so far as these figures are concerned, it is interesting to note how closely the various averages agree with each other. The average of the values in Column C (lowest temperature +10) is —8.61 F and the average of the values in Column D which of course is 5 deg less (lowest temperature +15) is —3.61 F. The latter compares favorably with the averages for Columns E and F, which are —3.81 F and —3.75 F, respectively. The average of the Column G figures is approximately —2 F.

The ASHVE Technical Advisory Committee on Weather Design Conditions has recently decided that the design dry-bulb temperature for winter should be taken as that temperature which is equalled or exceeded for 97½ per cent of the hours during the months of December, January, February and March. It will be interesting to see how design temperatures selected on this basis compare with temperatures selected on other bases.

Reiterating the statement previously made, whatever method is decided upon must necessarily be arbitrary, and it should be added, such a method to be generally acceptable should not produce results which will deviate greatly from the general practice in the majority of localities. For this reason, it is the author's opinion that the average annual minimum temperature (Column G, Table 3), provides a reasonably acceptable basis.

Table 3—Comparison of Design Temperatures by Various Methods

A	B	C	D	E	F	G
STATE	CITY	LOWEST TEMPERATURE EVER RECORDED +10 DEG†	LOWEST TEMPERATURE EVER RECORDED +15 DEG†	DESIGN TEMPERATURES COMMONLY USED‡	DESIGN TEMPS. BASED ON JANUARY NORMAL§	AVERAGE ANNUAL MINIMUM TEMPERATURES
Ala.	Birmingham	0	5	10	10	12
	Mobile	9	14	20	15	22
Ariz.	Flagstaff	—20	—15	—10	—10	—15
	Phoenix	20	25	25	20	26
Ark.	Fort Smith	—5	0	5	5	6
	Little Rock	—2	3	10	10	10
Calif.	Los Angeles	38	43	30	30	37
	San Francisco	37	42	30	25	37
Colo.	Denver	—19	—14	—15	—10	—11
	Grand Junction	—11	—6	—10	—10	—2
Conn.	New Haven	—5	0	0	—5	—1
D. C.	Washington	—5	0	0	0	—1
Fla.	Jacksonville	20	25	25	20	29
Ga.	Atlanta	2	7	10	10	12
	Savannah	18	23	15	15	22
Ida.	Lewiston	—13	—8	—5	0	1
	Pocatello	—18	—13	—10	—10	—12
Ill.	Chicago	—13	—8	—10	—10	—8
	Springfield	—14	—9	—10	—10	—7
Ind.	Evansville	—6	—1	0	0	1
	Indianapolis	—15	—10	—10	—10	—6
Iowa	Dubuque	—22	—17	—20	—15	—17
	Sioux City	—25	—20	—20	—15	—20
Kans.	Concordia	—15	—10	—10	—10	—13
	Dodge City	—16	—11	—10	—10	—10
Ky.	Louisville	—10	—5	—5	0	—5
La.	New Orleans	17	22	20	20	26
	Shreveport	5	10	10	10	16
Maine	Eastport	—13	—8	—10	—15	—15
	Portland	—11	—6	—10	—10	—6
Md.	Baltimore	3	8	10	0	8
Mass.	Boston	—8	—3	0	—5	—3
Mich.	Alpena	—18	—13	—10	—15	—12
	Detroit	—14	—9	—10	—10	—11
	Marquette	—17	—12	—10	—20	—13
Minn.	Duluth	—31	—26	—30	—25	—28
	Minneapolis	—24	—19	—20	—20	—23
Miss.	Vicksburg	9	14	15	15	18
Mo.	St. Joseph	—14	—9	—10	—10	—12
	St. Louis	—12	—7	—5	—5	—2
	Springfield	—19	—14	—10	0	—5
Mont.	Billings	—39	—34	—30	—20	—30
	Havre	—47	—42	—30	—25	—36
Nebr.	Lincoln	—19	—14	—15	—15	—13
	North Platte	—25	—20	—20	—15	—17
Nev.	Tonopah	—10	0	5	—5	—2
	Winnemucca	—26	—21	—15	—10	—10
N. H.	Concord	—25	—20	—20	—15	—15
N. J.	Atlantic City	1	6	5	0	6
N. Y.	Albany	—14	—9	—5	—10	—11
	Buffalo	—10	—5	0	—10	—4
	New York	—4	1	0	—5	—3
N. M.	Santa Fe	—3	2	0	—5	0
N. C.	Raleigh	8	13	15	10	13
	Wilmington	15	20	20	15	18
N. D.	Bismarck	—35	—30	—30	—30	—31
	Devils Lake	—36	—31	—30	—30	—33
Ohio	Cleveland	—7	—2	—5	—10	—2
	Columbus	—10	—5	—10	—5	—3
Okla.	Oklahoma City	—7	—2	0	0	2
Ore.	Baker	—15	—10	—15	—10	—17
	Portland	8	13	10	15	18
Penn.	Philadelphia	—1	4	0	0	6
	Pittsburgh	—10	—5	—5	—5	—2
R. I.	Providence	—7	—2	0	—5	1
S. C.	Charleston	17	22	15	15	22
	Columbia	8	13	10	10	19
S. D.	Huron	—33	—28	—25	—25	—26
	Rapid City	—24	—19	—20	—15	—21
Tenn.	Knoxville	—6	—1	0	0	2
	Memphis	1	6	0	5	9
Texas	El Paso	5	10	0	10	16
	Fort Worth	2	7	0	10	12
	San Antonio	14	19	10	15	21
Utah	Modena	—22	—17	—15	—10	—15
	Salt Lake City	—10	—5	—10	—5	2
Vt.	Burlington	—19	—14	—20	—15	—17
Va.	Lynchburg	3	8	10	5	8
	Norfolk	12	17	15	5	15
	Richmond	7	12	10	5	10
Wash.	Seattle	13	18	15	15	20
	Spokane	—20	—15	—15	—10	—5
W. Va.	Parkersburg	—17	—12	—10	—5	—1
Wis.	Green Bay	—26	—21	—20	—20	—18
	LaCrosse	—33	—28	—25	—20	—21
	Milwaukee	—15	—10	—10	—15	—12
Wyo.	Lander	—30	—25	—25	—20	—26
	Sheridan	—31	—26	—25	—20	—27

†Lowest temperature ever recorded up to 1943.
‡See ASHVE GUIDE, 1942, pages 130-131.
§From Column E, Table 2. (January normal minus 35 F, except 25 F on Pacific Coast, and adjusted.)

†Lowest temperature ever recorded up to 1943.
‡See ASHVE GUIDE, 1942, pages 130-131.
§From Column E, Table 2. (January normal minus 35 F, except 25 F on Pacific Coast, and adjusted.)

Members on Active Duty[1]

U. S. Army

ADAIR, J. S., Sgt., 20th T.S.S.
ARONSON, H. H., Pvt., M.P.E.G.

BACHMANN, A. J., S/Sgt., 588th Bomb Sqdn.
BACHOFER, H. A., Jr., T/Sgt., 983rd Bomb. Sqdn.
BADGETT, W. H., Lt.-Col., Infantry.
BARNES, H. S., Capt., 99th C. A. (aa)
BERNARD, E. L., Capt., Hq. 3rd Army, Engrs. Sec.
BERZELIUS, C. E., Lt.-Col., T.C.
BICHOWSKY, F. R., O.R.S., Air Support Command.
BOYD, R. L., Jr., 2nd Lt., Hq. Sec. Serv., C.U. 1976.
BROWN, H. J., 1st Lt., Ordnance.
BRUNDAGE, F. W., 1st Lt., 423rd C.A.
BRYAN, W. L., Lt., Hygiene Unit.
BURNS, F. G., Major, Infantry.

CALNAN, D. J., 1st Lt.
CAMPBELL, A. Q., Jr., Capt., F.A.
CAMPBELL, G. W., Major, Air Corps.
CARLOCK, M. F., Capt., C.E.
CASKEY, L. H., Jr., 1st Lt., Co. F., 38th Engrs.
CHAPIN, H. G., 1st Lt., Air Corps.
CHASE, R. E., Jr., Pfc., 417th Ordnance (Avn.)
CHEESEMAN, E. W., Major, Personnel Officer, Hq. 1004 Communication.
CLARK, A. C., Capt., F.A.
CLARK, J. R., Sgt., 24th A.D.G., Supply Sqdn.
CLEMENS, J. D., Capt., Air Corps.
CLOW, S. A., 1st Lt., Signal Corps.
COLBY, J. H., Major.
COST, G. W., A/C, Air Corps.
COX, V. G., Major, C.A.
CRAWFORD, A. C., Capt., Q.M.C.
CROLEY, J. G., Capt., C.A.
CROPPER, R. O., Capt., Q.M.C.

DABBS, J. T., 1st Lt., C.A.
DANIELSON, W. A., Brig.-Gen., U.S.A.
DAVIS, M. M., Pvt., Air Corps.
DEAN, David, Pvt., 30th ERTC.
DELAUREAL, W. D., Capt.
DIAMOND, D. D., S/Sgt., 801st S.T. Bn.
DICK, H. S., Pvt., Co. A., 361st Engrs.
DICKSON, D. R., 1st Lt., Air Corps.
DICKSON, R. W., Jr., Major, Air Corps.
DRUM, L. J., Jr., Capt., C.E.
DYER, W. S., S/Sgt.

ESCHENBACH, S. P., Capt., 62nd C.A. (aa)

FARLEY, W. S., Capt., 104th Q.M. Regt.
FELDSTEIN, Harold, Major, Ordnance.
FERDERBER, M. B., Capt., M.C.
FITZGERALD, W. E., Capt., 99th Infantry Div.
FLARSHEIM, C. A., 1st Lt., A.A.F. Trng. Aids Div.
FORDERBRUGGEN, K. J., Lt.-Col. 255th AAA Bn.
FOSTER, J. G., Major, Air Corps.
FRANKLIN, S. H., Jr., Major, Ordnance.
FREEMAN, A. W., 2nd Lt., Air Corps.
FRIEDLINE, J. M., Capt., C.E.

GAULT, G. W., Capt., C.E.
GEBEL, K. M., Cpl., Air Corps.
GOLDSMITH, Elliot, T/5.
GONZALEZ, J. L., Pilot, Air Corps.
GRABMAN, H. B., 1st Lt., 95th Engrs. Regt.
GREEN, E. W., Pvt., 87th Bn.

HAMILTON, J. B., 1st Lt., C.E.
HAWES, H. D., Lt., Instructor, A.A. School.
HENDRICKSON, W. B., S/Sgt., Air Corps School.
HERBERT, J. S., 1st Lt., Co. A., 385th Engrg. Bn.
HERBERT, R. M., Lt., Air Corps.
HILL, Edward, Jr., Capt., F.A.
HINNANT, C. H., Jr., Capt., C.E.
HOLMES, R. E., 1st Lt., C.E.
HOOVER, W. L., 1st Lt., C.E.
HUBBUCH, N. J., 2nd Lt., Air Corps.
HUGHES, Samuel, Cpl., 59th Bn., Co. B.
HUNT, MacDonald, Capt., C.E.
HUST, C. E., Capt., Ordnance.
HUTCHINSON, B. L., Jr., 2nd Lt., Air Corps.

IBISON, J. L., Capt., Post Engr.
INMAN, C. M., 1st Lt., Air Corps.

JAKOBY, A. C., Pfc., Signal Corps.
JONES, H. S., 1st Lt., 17th Air Depot Group.
JONES, J. T., 2nd Lt., E.R.C.

KELLOGG, W. T., Capt., Air Corps.
KELLY, Olin A., A/C, Air Corps.
KILLOREN, D. E., 1st Lt., Hq. Co., 15th Infantry.
KLUCKHUHN, F. H., A/C, A.A.F.T.S.
KOENIG, A. C., T/Sgt., 113th Engr. Cbt. Bn.
KROEKER, J. Donald, Capt., C.E.
KUMMER, C. J., 1st Lt., F.A.
KURTZ, R. W., Capt., Ordnance.

LANGAN, James, Pfc., C.I.T.
LARSON, C. P., Sgt., Hq. and Students Det.
LASETER, F. L., 1st Lt., Co. FE.
LENONE, J. M., Lt.-Col. C.E.
LEUPOLD, G. L., Capt., Signal Corps.
LEWIS, H. F., Capt., C.A.
LIFTON, David, Lt., Air Corps.
LIGHT, J. C., Capt., Ordnance
LINDSAY, G. W., Jr., Pvt., Co. S, 1st Regt.
LLOYD, E. H., Capt., Office, Chief of Engrs.
LONG, W. E., Capt., Signal Corps.

MACEACHIN, G. C., Major, Engrs. Aviation Bn.
MACGREGOR, C. M., Major, Ordnance.
MACMILLAN, A. R., Lt.-Col., Air Corps.
MALIN, B. S., Capt., Ordnance.
MARINO, F. A., T/Sgt. (Overseas).
MARSHALL, T. A., 1st Lt., C.E.
MARSTON, A. D., Lt.-Col., C.E.
MCCAIN, H. King, Capt., Q.M.C.
MCCLUNG, T. H., Capt., F.A.
MCDERMOTT, J. P., Capt., C.E.
MCGOWN, F. H., Jr., Pfc., 7th T.S.S.
MCKAY, A. W., Capt., Ordnance.
MOORE, H. W., 1st Lt., Ordnance.
MORAWECK, A. H., Jr., 1st Lt., CRTC.
MORTON, H. S., Lt.-Col., Ordnance.

NEAL, J. P., Capt., Ordnance.
NELSON, A. W., Major, C.E.
NORRINGTON, W. L., 1st Lt., Ordnance.

ORGELMAN, G. H., Btry. A, 140 AAA.
OTTS, J. G., 1st Lt., Ordnance.

PARKER, R. A., 1st Lt., 749th M.P. Det.
PAWKETT, L. S., Capt., Air Corps.
PEISER, M. B., 1st Lt., Air Corps.
PELLMOUNTER, T. V., 2nd Lt., 55th Ordnance.
PETERSON, J. R., Pfc., Co. B, 1525 Serv. Unit.
PLOSKEY, E. J., Sgt., 40th Ordnance Co.
PHILLIPS, R. H., 1st Lt., Infantry.
PHILLIPS, W. L., Major, Air Corps.
PLEUTHNER, R. L., 2nd Lt., Air Corps.
PRAWL, F. E., Capt., Ordnance.
PREBENSEN, H. J., Major, Ordnance.
PRICE, C. F., Lt., Q.M.C.

REIF, A. F., Col., 74th Infantry.
RHEAULT, W. E., Capt., C.E.
RHINE, G. R., Major, Ordnance.
RICHARDS, G. H., Lt., C.E.
RIESECK, W. L., 2nd Lt., C.E. (Reserve).
ROBERTS, H. P., T/Sgt., H. & S. Co., 1307 Engr. G. S. Reg't.
ROSSITER, I. J., Capt., A.C.
ROTHMAN, S. C., Capt., Sn. C., Occupational Hygiene Div.
RUEMMELE, A. M., 1st Lt., Ordnance Section, PRGD.

SACHS, Sam, Pvt., C.E.
SANDERS, C. M., Jr., Lt., Signal Corps.
SANDFORT, J. F., Capt., 303 F.A. Bn.
SATTERLEE, H. A., Capt., Ordnance.
SAURWEIN, G. K., Major, Ordnance.
SCHNEEBERG, F. H., Sgt., Q.M.C.
SCHLICK, P. F., Col., C.A.
SCHROEDER, W. R., Pvt., 345th Infantry.
SEMEL, Edward, Pfc., 442nd Fighter Sqdn., Air Corps.
SHARP, J. R., Major, C.E.
SHEARER, W. A., Jr., 2nd Lt., C.E.
SHELL, J. D., Lt., C.E.
SLOANE, D. J., 56th General Hospital.
SNYDER, E. F., Capt., C.E.
SNYDER, E. J., Officer Candidate Reg't., C.E.
SOBEL, Frank, Pvt., Co. A, 101 M.B. Bn.
SOMMERFIELD, S. S., Pvt., Co. B.
SPENCE, R. A., Capt., Ordnance.
STENGEL, F. J., 1st Lt., Engrs. Bn.
STERNER, D. S., Capt., 282nd Q.M.C.
STEVENS, E. K., Capt., Liaison Officer.
STEVENS, K. M., Capt., C.A., 108th AA Gun Bn.
STROTHER, W. E., Capt., C.E.
SUTCH, H. C., Capt., Umatilla Ordnance Depot.

TICHENER, L. R., Jr., Lt., Range Officer.
TRAYNOR, H. S., Capt., C.E.
TUTHILL, A. F., 2nd Lt., Air Corps.

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[1] Compiled as of June 1, 1944.

Van Nouhuys, H. C., 1st Lt., Signal Corps.
Vinson, N. L., 1st Lt., C.E.

Wangsgaard, Dee, 1st Lt., N.M.B. A.U.S.
Warren, R. M., Lt., Air Corps.
Watson, G. M., Lt., G.H.D. of H.D.C.
Weatherby, E. P., Jr., Major, Air Corps.
Weaver, J. v. O., Lt.-Col., Air Corps.
Webster, Warren, Jr., Major, Ordnance.
Werner, P. H., Capt., Signal Corps.
Williams, H. E., Pfc., Air Transport Section.
Wills, F. W., Lt., 5th Airforce Flying Trng. Det.
Wilson, W. E., Lt.-Col., S.W.T.C.
Wolin, Milton, A/C, Air Corps.

Zeigler, D. D., Lt., Air Corps.
Zink, D. E., Lt.-Col., G.S.C., 1st Arm'd. Corps.

U. S. Navy

Akers, G. W., Capt., U.S. Navy Yard.
Anderson, D. B., Lt. (jg), USNR.
Andrews, W. G., Mach. A-V (S), USNR.
Arenberg, M. K., Lt.-Comdr., USNR.
Arvidson, E. R., Lt. (jg), USNR.
Ash, R. S., Lt. (jg), USNR.
Austin, W. H., Lt. (jg), USNR.

Baber, H. L., Jr., Lt., U.S.S. Cushing.
Baker, H. L., Jr., Lt. (jg), USNR.
Baker, R. H., Comdr., USNR.
Bastedo, G. R., Ensign, USNR.
Bensinger, Mark, Lt. (jg), USNR.
Bible, H. U., Lt. (jg), USNR.
Blair, D. W., Cpl., USMCR.
Bouillon, Lincoln, Lt., 92nd M.C.B., USNR.
Boyd, S. W., Lt., USNR.
Braun, C. R., Jr., Midshipman, USNR.
Brissenden, C. W., Lt., USNR.
Burges, J. H., RT 3/c.
Burton, W. R., Warrant Officer, USNR.

Campbell, R. P., Ensign, USNR.
Carter, J. H., Lt., USNR.
Cary, E. B., Comdr. (CEC), USNR.
Chapman, W. A., Jr., Lt.-Comdr., USNR.
Childs, L. A., Lt., E-V (S), USNR.
Chipman, E. E., Jr., Ensign, U.S.S. Litchfield.
Cooperman, E., S/2c, ABHTU, NAS.
Cover, R. R., Warrant Officer, E-V (S), USNR.
Curley, E. I., Lt., USNR.

Daddario, F. T., Ensign, USNR.
Danowitz, C. J., Ensign, USNR.
Davidson, J. C., Lt., USNR.
Davis, Charles, Chief Petty Officer, USNR (Seabees)
Dean, F. J., Jr., Lt. (jg), USNR.
Dovener, R. F., Lt., USNR.
Driemeyer, F. C., Lt. (jg), USNR.

Eggers, W. K., Lt. (jg), USNR.
Eutsler, E. E., Jr., Lt., USNR.
Evans, R. W., Lt.-Comdr. (CEC)-V (S), USNR.
Everetts, John, Jr., Lt. O-V (P), USNR.

Floreth, J. J., Lt. (jg), USNR.
Fly, E. P., Hq. Co. 80th, USNCB.
Forbes, H. B., Jr., Lt. (jg), USNR.
Fuller, R. A., Lt.-Comdr., USNR.
Fullman, J. B., Ensign, USNR.

Gregg, S. L., Lt., USNR.
Griest, K. C., Warrant Officer (CEC), USNR.
Griffin, C. J., Lt. (jg), USNR.
Griffith, H. T., Lt., USNR.

Harrigan, E. R., Lt., USNR.
Hart, J. H., Lt., USNR.
Herman, N. B., Lt. (jg), USNR.
Hero, G. A., Jr., Lt.-Comdr., USNR.
Herre, H. A., Lt. (jg), USNR.
Hertzler, J. R., Lt., USNR.
Holden, R. G., Lt., USNR.
Holland, R. G., Lt., USNR.
Holland, W. T., Lt. (jg), USNR.
Houghten, F. C., Comdr., USNR.

Iverson, H. R., Lt. (jg) D-V (S), USNR.

Johnston, R. M., Lt. (jg), USNR.
Jordy, J. J., Lt., USNR.

Kahn, C. R., Jr., Lt., USNR.
Keyes, M. W., Lt. (jg), USNR.
Killian, W. J., Lt., USNR.
Kolasa, M. J., Ensign, E-V (S), USNR.
Kolb, R. P., Lt.-Comdr., USNR.
Kunen, H. K., Ensign, USNR.

Ladd, David, Lt.-Comdr., USNR.
Landauer, L. L., Lt.-Comdr. (CEC), USNR.
Lange, F. F., Lt., USNR.
Levine, L. J., Ensign, USNR.
Levitt, L. L., Lt., USNR.
Lieblich, Murray, Lt. (jg), USNR.
Locke, R. A., Lt.-Comdr., USNR.
Long, E. J., Jr., Ensign (E-US), USNR.
Loughran, P. H., Jr., Ensign, USNR.
Lyford, R. G., Ensign, USNR.
Lyon, D. M., Pfc., USMC.

Mabley, L. C., Lt., USNR.
Matheka, C. R., U.S.S. Tattnall.
Matthies, L. A., Ensign, USNR.
May, M. F., Lt., USNR.
McCormick, G. W., Jr., 1st Lt., USMC.
McDowell, H. L., Ensign, USNR.
Melton, R. D., C.M. 1/c
Millard, J. W., Lt., Organized Reserve.
Minor, J. E., Ensign, USNR.
Mitchell, A. E., Lt. (jg), USNR.
Mitchell, A. J., Lt. (jg), USNR.
Morse, L. S., Jr., Lt. (jg), USNR.
Nottberg, Henry, Jr., Seabees.
Noyes, R. R., Ensign (AUS), USNR.

Paetz, G. A., Lt. (jg), USNR.
Paine, H. A., Ensign, USN.
Parkinson, J. S., Lt.-Comdr., USNR.
Peller, Leonard, Lt. (jg),, USNR.
Porter, N. E., Ensign, USNR.
Powers, N. E., Ensign, USNR.

Queer, E. R., Lt.-Comdr., USNR

Rainson, S. J., 2/c Machinist Mate.
Ray, G. E., Elect. Mate 2/c, USCG.
Reed, W. H., III, Lt. (jg), USNR.
Riley, J. N., Lt., E-V (S), USNR.
Rodee, E. J., Lt., USNR.
Rogers, C. S., Lt. (jg), USNR.

Schechter, J. E., Lt. (jg), USNTS.
Sgambati, A. P., USNR.
Shapiro, C. A., Lt., USNR.
Simpson, R. L., Lt. (jg), USNR.
Smith, C. F., Jr., Lt. (jg), USNR.
Spitzley, J. H., S. 2/c.
Stacey, A. E., Jr., Capt., USNR.
Steel, R. J., Lt., USNR.
Sterne, C. M., Lt.-Comdr., USNR.
Stokes, T. A., Lt. (jg), USNR.
Sullivan, T. J., Ensign, USNR.

Timmis, W. W., Lt.-Comdr., USNR.
Tracy, W. E., Lt. (jg), USNR.
Turner, J. P., Jr., Lt. (jg), USNR.

Urdahl, T. H., Comdr., E-V (S), USNR.

Van Alsburg, J. H., Lt., USNR.
Vervoort, E. L., Lt. (jg), USNR.
Vetlesen, G. U., Lt.-Comdr., USNR.

Walden, H. K., C.S.F., USNR.
Westphal, N. E., Lt., U.S.S. Canberra, USNR.
Widdowfield, A. S., Lt., USNR.
Wildman, E. L., Lt. (jg), USNR.
Williams, G. E., A/S, USNCTC.
Williams, F. H., Lt. (jg), USNR.
Wilson, A. M., Ensign, USNR.
Workman, A. E., Lt. (jg), USNR.
Wyld, R. G., Lt., USNR.

Younger, J. R., Sp. 3/c (T), USNR.

Zintel, G. V., Lt. (jg), USNR.
Zurow, W. A., Ensign, USNR.

Rank and Branch of Service Unknown

Bates, J. H.
Blum, R. J., Jr.
Braniff, P. R.
Breyer, Frederick.
Cannon, B. K.
Dillender, E. A.
Faxon, H. G.
Holmes, D. W.
Holzer, R. J., Jr.
Johnson, L. O.
Kotzebue, R. W.
Link, C. H.
Meates, R. F.
Melton, H. E.
Ormiston, J. B.
Rodeffer, E. W.
Roper, R. F.
Rosas, M. L.
Ross, D. S.
Smith, W. P.
Tutsch, R. J.
Volk, G. H.
Von Rosenberg, P. C.
Wright, N. S., Jr.

Members in Allied Service

ALLSOP, R. P.*
ARMOUR, E. G., RCAF.
BALLANTYNE, G. L., Instructor, RCAF.
BARRETT, C. M., Capt., Canadian Army.
BELLMAN, J. V., Ch. Petty Officer.
BISHOP, J. W., Lt.-Col., Canadian Active Service Forces.
BODMER, Emmanuel, Lt., Air Force.
BOWERMAN, E. L., Fl/Lt., RCAF.
BUTT, Roderick E. W.*
DANIEL, W. E., 2nd Lt., Royal Artillery
DION, A. N., F/O, RCAF.
DOWLER, E. A., Lt., Canadian Army, RCOE.
FOX, J. H., Lt.-Col., Ordnance Co., Canadian Army.
HILL, H. G., Sub. Lt., Engr., RCNVR.
JOHNS, C. F., Sqdn. Leader, RCAF.
KITCHEN, W. H. J., Elec'l Lt., RCNVR.
LABONNE, Henri, Capt., Canadian Army.
MARRINER, J. M. S., Lt.-Comdr., RCNR.
MACLACHLAN, V. D., Fl/Lt., RCNVR.
NORFOLK, L. W., Lt.-Col., H. M. Forces, Royal Engrs.
McDONALD, Ivan.*
NEVIN, J. F., Capt., Hq., Eastern Command.
NOVOLANSKY, S. I., Fl/Sgt., RCAF.
PENNOCK, W. B., Lt.-Col., RCE, 8th Canadian Div.
POUGHER, B. R. E., Sgt., 110 (el) A. T. Coy R. E.
PRICE, E. H., Capt., Q.M.C., RCE.
PRYKE, J. K. M.,† Capt., Royal Army Ordnance Corps.
RICHARDSON, R. D., Sgt., Bombardier, Royal Regt. Artillery.
ROBINSON, Jack A.*
SMITH, G. E., Major, RCE.
WILKINSON, Arthur, Fl/Lt., RCAF.
WOOD, A. W., Fl/Lt., RCAF.

Killed in Action

FOSTER, Phil H., Wing Commander in RAF (Flin Flon, Manitoba, Canada.)

TEMPLE, Harold L., Flying Officer, RAF (London, England).

†Prisoner of war.
*Rank and Branch of Service unknown.

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F. C. HOUGHTEN NOW COMMANDER

The recent promotion of F. C. Houghten to the rank of Commander with the U. S. Navy was announced. His duties with the Navy have pertained to the improvement of living conditions on naval vessels as affected by the atmospheric environment. They have, therefore, continued along the lines of much of his previous research work for the Society. He is attached to the Research Division of the Bureau of Medicine and Surgery in Washington, D. C.

Comdr. F. C. Houghten

KURTZ IN THE ALEUTIANS

S/Sgt. Adolph E. Kurtz, formerly on the staff of the Research Laboratory, is now somewhere in the Aleutians. He sends greetings, and reports that he sees the results of the Society's past work in the far north, a place "of ever-changing weather, with wind, fog, snow, rain, and very little sunshine. We are quartered in Pacific and Quonset Huts, which very satisfactorily solve the urgent housing problems in this and similar theaters of operations. These huts are quite comfortable, mostly because of their efficient use of insulation, and the simple but efficient oil-heating stoves used in them. I feel certain that the Society's research and standardization work had much to do with the design of these comfortable quarters for our servicemen."

Since last December Sergeant Kurtz has been on his present assignment with the Army Service Forces handling personnel administration, where a specially trained group of technicians provides orientation, recreational, and athletic activities for troops in the Aleutians' theater.

In his note to the Secretary of the Society, Sergeant Kurtz said, "I trust that the great work of the ASHVE continues as an integral part of our united war effort." For anyone desiring to write him, he should be addressed: 38th Special Service Co., APO 980, care Postmaster, Seattle, Wash.

S/Sgt. A. E. Kurtz

COLUMBUS GROUP HOLDS MEETING

At a meeting of ASHVE members in Columbus, Ohio, June 19, action was taken to organize a Central Ohio Chapter of the Society. Allen W. Williams, Secretary of the organizing group, announced that there were 28 on the Charter Membership roll, and they had signed a petition for a charter.

The guest speaker was R. Louis Towne, Surface Combustion Corp., Toledo, Ohio, who addressed the gathering on Aircraft Heaters. Mr. Towne gave a graphic picture of the problems in aircraft heating, and his talk was interesting and instructive. As a result of the discussion it is believed that there will be an increase in the membership of the Columbus group. The next meeting is scheduled for Tuesday, September 12, 1944.

MINE VENTILATION

Construction details for a standard-type mine door frame and interchangeable mine ventilating doors, used with considerable efficiency in anthracite collieries of a Pennsylvania mining company, are contained in a Bureau of Mines information circular 7280, just released by Dr. R. R. Sayers, Bureau Director, Washington 25, D. C.

The publication contains drawings showing the elevation, plan view, and details for building the door and door frame.

SUMMARY OF LOCAL CHAPTER MEETINGS

Chapter	Meeting Date	Subject	Speakers	Other Features	Attendance	Attendance Ratio*
Atlanta	May 29		None	Georgia Society of Measurement Control was host to ASHVE. General Electric Co. contributed three films "Frequency Modulation," "Welding" and "Television."	15	0.32
Cincinnati	June 6	Annual Meeting		Election of Officers	48	1.0
Delta	May 2		None	Election of Officers Education Sound Film of Sperry Gyroscope was presented	21	0.49
Golden Gate	May 3	Automotive Radiator Development	L. P. Saunders, Treasurer of ASHVE, Lockport, N. Y.	Election of Officers	41	0.50
Illinois	May 8	Annual Meeting Present and Future of Society	 S. H. Downs, Pres. of ASHVE, Kalamazoo, Mich.	 Mrs. Downs was introduced by Pres. C. E. Price Report of Tellers announced	77	0.51
Indiana	May 26	Electronics in Industry	Karl Keller, General Electric Co.	Pres. W. C. Bevington announced appointment of Membership, Legislative, Finance, and Meetings Committees	41	0.56
	April 19	Air Conditioning and Heating in South America	A. J. Offner, 2nd Vice-Pres., ASHVE, New York, N. Y.	Election of Officers Report from Treasurer, and Membership and Legislative Committees' Reports were presented C. F. Boester, St. Louis, was a guest	52	0.72
Iowa	April 12	History of the Seed Corn Drying Industry	Clarence North, Chief Engr., Campbell Heating Co., Des Moines	Discussion on a State Ventilating Code	17	0.71
Kansas City	May 23	The Lure of the Curve Ahead	E. W. Miller, Managing Editor, Olathe Mirror	Installation of Officers	79	1.06

CHAPTER	MEETING DATE	SUBJECT	SPEAKERS	OTHER FEATURES	ATTENDANCE	ATTENDANCE RATIO*
Massachusetts	May 16	Refrigeration and Air Conditioning at the Pentagon Bldg., Washington, D. C.	C. S. Leopold Cons. Engr. Philadelphia, Pa	Joint meeting with ASRE	47	0.83
Michigan	May 23	Annual Meeting	None	Capt. M. F. Carlock, St. Louis, Mo., was introduced. Resolutions on death of W. E. Stark were adopted Report of Tellers submitted Past President's Memory Book presented to S. S. Sanford	63	0.60
Minnesota	May 22	Activities of Chapter During Past Year	Pres. F. W. Legler	Election of Officers	68	1.0
Montreal	May 15	Inspection trip through the Noorduyn Aviation Plant	None	Leo Garneau was elected official delegate to Semi-Annual Meeting	19	0.33
Nebraska	May 9	Resume of Events Scheduled for Future Meetings	B. G. Peterson	Report of Nominating Committee was submitted "Soldiers of the Soil," a film by E. I. du Pont de Nemours & Co., Inc.	20	0.85
New York	May 15	Engineering Highlights of the Salvaging of the Normandie	A. C. W. Siecke Cons. Engr., Merritt - Chapman Scott Corp., New York, N. Y.	Pres. R. A. Wasson introduced J. W. Markert, Washington, D. C., as guest	158	0.86
Northern Ohio	May 8	Development of All-Year Air Conditioning	Dr. M. E. Berry, Dir. of Research Servel, Inc.	L. T. Avery reported on supply of "Freon" and its allocation	62	0.70
		Air Conditioning Unit and Its Applications	H. C. Peirce, Asst. Mgr., Air Cond. Div., Servel, Inc.	G. L. Tuve reported for Nominating Committee		
North Texas	May 15	Masters of Molecules (film in technicolor)	Presented by H. D. Fowlkes, The Texas Co.	E. J. Stern reported on status of membership	44	0.65
Oklahoma	May 31	Phases of Chapter Activity	E. T. P. Ellingson Pres. of Chapter	A round-table discussion followed Election of Officers announced	9	0.90
Oregon	April 11	The Flow of Gas and Air in Various Systems	S. H. Downs, Pres. of ASHVE, Kalamazoo, Mich.	Installation of Officers	23	0.34

CHAPTER	MEETING DATE	SUBJECT	SPEAKERS	OTHER FEATURES	ATTENDANCE	ATTENDANCE RATIO*
Pacific Northwest	May 3	Radiant Heating	Erwin L. Weber	Prof. E. O. Eastwood introduced speaker Newly elected officers announced	29	0.53
Philadelphia	May 11	Annual meeting	None	Edwin Elliot turned the gavel over to A. C. Caldwell, incoming president	59	0.48
Pittsburgh	May 15		None	A. F. Nass reported for Nominating Committee Miss Faye Parker entertained with songs	32	0.52
St. Louis	May 9	Flow of Air and Gases in Various Systems	S. H. Downs, Pres. of ASHVE, Kalamazoo, Mich.	In celebration of 25th Annual Meeting of St. Louis Chapter, 13 Past Presidents were in attendance Installation of new officers	52	0.88
South Texas	May 29	The Kilgore Bill No. S. 702 (Delta Chapter's action endorsed by South Texas Chapter)	Messrs. Brandt, Barnes, Cooper and Fisher	Election of Officers	17	0.74
Southern California	May 10	Activities of the Plastic Industry	John Delmonte	Newly elected officers announced	42	0.56
Western Michigan	April 17	Outline of Program for Semi-Annual Meeting in Grand Rapids New Foods Make News (sound movie)	T. D. Stafford, General Chairman, Committee on Arrangements Presented by Messrs. Delahanty and Hartman, Birds Eye-Snyder, Inc.	Report of Nominating Committee given by Prof. L. G. Miller	27	0.90
Western New York	May 8	Annual Meeting	None	B. C. Candee reported as Treasurer Installation of Officers M. C. Beman presented the past presiding certificate to retiring Pres. S. M. Quackenbush	35	0.54

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*The attendance ratios shown represent the meeting attendance divided by the Chapter membership. These will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by other local chapters and may be helpful in deciding on subjects for other chapter meetings.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 52 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by July 15, 1944, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
ALEXANDER, JOHN L., Mfrs'. Agent, Grand Rapids, Mich.	W. W. Bradfield T. D. Stafford	F. C. Warren Hero D. Bratt
BARNES, JOHN C., Br. Mgr., National Radiator Co., Washington, D. C.	W. H. Littleford W. D. Marshall	E. J. Febrey Henry Norair
BATEMAN, WILLIAM H., Partner, Keystone Sales Co., Pittsburgh, Pa.	E. S. Tower P. A. Edwards	J. F. Collins, Jr. E. C. Smyers
BELDEN, A. G., JR., Pres., Refrigeration & Appliance Service, Inc., Terre Haute, Ind.	S. E. Fenstermaker, Jr. G. B. Supple	W. C. Bevington C. W. Stewart
BOYER, C. L., Consulting Engr., Dillon, Mont.	T. J. Sullivan E. K. Webster	E. N. McDonnell J. C. Kelly
BREN, LEO W., Asst. Mgr., Grudem Brothers Co., St. Paul, Minn.	H. R. Nichols William McNamara	J. A. Craig R. E. Gorgen
BUCKINGHAM, R. B., Partner, Associated Southern Industries, Memphis, Tenn.	W. E. Thorpe J. D. Flinn	W. A. Danielson J. J. Nolan
CALLAN, WILLIAM D., Dept. Mgr., The Philip Carey Manufacturing Co., Lockland, Ohio.	W. A. Juergens K. A. Wright	T. D. Boyd E. J. Richard
CODERE, J. M., Director, Codere, Ltd., Sherbrooke, Que., Canada.	A. F. Lamontagne R. A. Standring	F. A. Hamlet Leo Garneau
DAWSON, FRED C., Engr., B. F. Sturtevant Co., Boston, Mass.	A. C. Bartlett R. L. Lincoln	*W. G. Perrings Earl Carrier
DEUTH, GERALD Q., Asst. Engr., Engrg. Experiment Sta., Ohio State University, Columbus, Ohio.	D. H. Wyatt J. D. Slemmons	H. R. Allonier A. I. Brown
FERRETTI, JULIUS J., N. Y. Mgr., U. S. Air Conditioning Corp., New York, N. Y.	L. P. Hanson V. J. Cucci	D. G. Milligan Ira Willner
FOSS, BENJAMIN S., JR., Field Engr., B. F. Sturtevant Co., Dallas, Tex.	L. C. McClanahan J. A. Ray	W. H. Moler R. E. Allison
FOX, ERNEST C., Mgr., Htg. & Cooling Dept., Hager & Cove Lbr. Co., Lansing, Mich.	L. G. Miller C. H. Pesterfield	T. D. Stafford W. W. Bradfield
GRAY, EMERSON G., Food Engr., Featherweight Foods, Inc., Fort Kent, Me.	W. C. Jones S. L. Gregg	Lester Maurer Fred A. Leser
JASPER, HAROLD C., Pres., Andy J. Egan Co., Inc., Grand Rapids, Mich.	H. D. Bratt T. D. Stafford	C. H. Pesterfield W. W. Bradfield
JENNINGS, JAMES H., Htg. & Vtg. Engr., General Electric Co., Fort Wayne, Ind.	S. E. Fenstermaker, Jr. G. B. Supple	W. C. Bevington C. W. Stewart
KEATTS, ROLLA M., Field & Sales Engr., Russell R. Gannon Co., Cincinnati, Ohio.	W. M. Myler, Jr. D. H. Wyatt	J. D. Slemmons A. W. Williams
LAWS, CHARLES W., Plant Supvr. of Htg., Rapid City Army Air Base, Rapid City, S. D.	O. E. Davis J. M. Townsend	F. M. Thomas M. A. Disney
LEES, JOHN, Engr., Board of Education, Detroit, Mich.	H. P. Dolan *J. M. Nadon	*John Gretzinger *Alfred Cant
MARSHALL, HAROLD W., Mech. Engr., T. H. Buell & Co., Denver, Colo.	D. J. McQuaid F. L. Adams	J. H. McCabe G. D. Maves
MARTIN, W. A., Mgr., Air Cond. Dept., American Heating Co., Washington, D. C.	A. P. Mergardt R. K. Thulman	C. T. Sluder T. H. Urdahl
MATHIS, ALEXANDER, Mech. Engr., Reynolds, Smith & Hills, Jacksonville, Fla.	A. J. Edge J. C. Pastor	F. J. Beckwith M. F. Blankin
McDANIELS, JAMES A., Air Cond. Attendant, Allison Div., General Motors Corp., Indianapolis, Ind.	R. D. Tutt R. I. Drum	W. C. Bevington C. W. Stewart
MEYER, E. WALTER, Partner, Keystone Sales Co., Pittsburgh, Pa.	A. F. Metzger T. F. Rockwell	E. C. Smyers E. S. Tower
MONIES, ELLIS A., Htg. Engr., Eastern Pennsylvania Supply Co., Wilkes-Barre, Pa.	M. F. Blankin A. E. Kriebel	A. P. Morrow H. H. Erickson
NICHOLS, L. F., Br. Mgr., American Radiator & Standard Sanitary Corp., Columbus, Ohio.	J. D. Slemmons H. R. Allonier	R. B. Breneman W. M. Myler, Jr.
NOLL, MICHAEL P., Air Cond. Sales Engr., Servel, Inc., Houston, Tex.	A. B. Banowsky F. C. Brandt	B. P. Fisher A. F. Barnes
NORMAN, EDWARD A., JR., Design Engr., Surface Combustion, Columbus, Ohio.	W. M. Myler, Jr. D. H. Wyatt	J. D. Slemmons H. R. Allonier
PASEK, LEONARD E., Development Engr., Kimberly-Clark Corp., Washington, D. C.	R. S. Dill S. L. Gregg	Lester Maurer F. B. Sale
POTTER, CHRISTOPHER D., Supt. & Engr., The Smith-Gibbs Co., Providence, R. I.	E. W. Gibbs J. C. Hartwell	J. B. Coleman R. L. Blanding
POTTS, AMOS P., Chief Engr., Logan Clay Products Co., Logan, Ohio.	D. H. Wyatt A. I. Brown	J. D. Slemmons H. R. Allonier
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ROSS, KENNETH A., Engr., Vancouver School Board, Vancouver, B. C., Canada.	C. H. Turland C. W. Leek	Einar Anderson R. E. Johnston
ROTTMAN, GEORGE B., Engr., W. H. Sullivan Co., Inc., Greensboro, N. C.	C. Z. Adams F. E. P. Klages	Karl Selden, Jr. W. H. Sullivan
SACK, HERMAN S., Archt. & Engr., Waldorf System, Inc., Boston, Mass.	T. P. Mandell E. G. Carrier	J. P. Licandro J. W. Brinton

Savoie, J. L. Roland, Codere, Ltd., Sherbrooke, Que., Canada.	A. F. Lamontagne R. A. Standring	F. A. Hamlet Leo Garneau
Shaw, George W. D., Supt. & Engr., Lorne P & H Co., Detroit, Mich.	W. H. Old E. F. Hyde	R. S. M. Wilde F. X. Marzolf
Speer, Julian, Mgr., Julian Speer Co., Columbus, Ohio.	J. D. Slemmons D. H. Wyatt	H. R. Allonier R. B. Breneman
Spencer, Irvin B., Owner, Irvin B. Spencer Co., Columbus, Ohio.	D. H. Wyatt R. B. Breneman	J. D. Slemmons H. R. Allonier
Stern, Lester M., Student, Case School of Applied Science, Cleveland, Ohio.	G. L. Tuve *D. K. Wright, Jr.	L. G. Seigel *R. V. Brown
Sullivan, W. H., Jr., Vice-Pres., W. H. Sullivan Co., Inc., Greensboro, N. C.	C. Z. Adams Harry Hoffman	Karl Selden, Jr. P. L. Guest, Jr.
Underwood, George T., Federal Public Housing Authority, Washington, D. C.	C. R. Kidd H. H. Koster	R. Skagerberg S. L. Gregg
Visintine, Edward C., Owner & Mgr., Madison Plumbing & Heating Co., London, Ohio.	H. R. Allonier J. D. Slemmons	R. B. Breneman W. M. Myler, Jr.
von Otto, Robert E., Naval Archt., U. S. Maritime Commission, Washington, D. C.	J. W. Markert J. H. Fogg	F. A. Leser H. H. Hill
Walters, Thomas A., Dir. of Research, American Blower Corp., Detroit, Mich.	E. L. Hogan H. E. Barth	A. P. Darlington H. E. Paetz
Whealton, Daniel J., Chief Draftsman & Supvr., Atlantic Basin Iron Works, Brooklyn, N. Y.	V. J. Cucci D. G. Milligan	M. S. Smith W. W. Short
Will, Clarence A., Mfr's. Repr., Indianapolis, Ind.	J. E. Clemens R. D. Tutt	W. C. Bevington S. E. Fenstermaker
Wilson, Kentner L., Branch Mgr., Minneapolis-Honeywell Regulator Co., Detroit, Mich.	F. C. Purcell G. D. Winans	H. E. Paetz H. E. Ziel
Winter, Claude L., Engr., Link-Belt Co., Grand Rapids, Mich.	W. W. Bradfield F. C. Warren	H. D. Bratt C. A. Simonds
Witheridge, William N., Director & Chief Engr., Bureau of Industrial Hygiene, Detroit Department of Health, Detroit, Mich.	T. H. Mabley R. H. Berryman	R. H. Oberschulte R. D. Randall
Woodbridge, William L., Owner, Woodbridge Plumbing & Heating, Milford, Mich.	M. B. Shea J. B. McCrea	W. G. Boales F. X. Marzolf

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*Non-Member.

Candidates Elected

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

Bazille, Clarence H., Mgr. of Htg. Dept., Harry Lee Plumbing & Heating, Burlingame, Calif.

Bean, Thomas H., Jr., Utilization Engr., New Orleans Public Service, Inc., New Orleans, La.

Chadwick, John B., Engr. Repr., Manchester Dist., Colwyn Chambers, Manchester, England. (*Reinstatement*)

Crew, Morris W., Dept. Mgr., Perfex Corp., Milwaukee, Wis.

Dunlap, R. L., Engr., John H. Kitchen & Co., Kansas City, Mo. (*Reinstatement*)

Dusossoit, Edmond A., Treas., Lynch & Woodward, Inc., Boston, Mass. (*Reinstatement*)

Gardner, Francis B., Secy.-Treas., H. S. McClelland, Inc., Los Angeles, Calif.

Hartsfield, Charles G., Field Refrigeration Engr., Hq. Fourth Service Command, Atlanta, Ga.

Hilmer, Ralph H., Engr., C. G. Hokanson Co., Los Angeles, Calif.

Hummel, David M., Mgr. of Engrg., Yale University Service Bureaus, New Haven, Conn.

Koubek, J. V., Engr., National Carbon Co., Cleveland, Ohio.

L'Hommedieu, Curtiss L., Htg., Vtg. & Fire Protec. Engr., The Foskett & Bishop Co., New Haven, Conn.

McDonald, Frank L., Branch Mgr., Barber Colman Co., Los Angeles, Calif.

Murray, William W., Jr., Vice-Pres., Almirall & Co., Inc., New York, N. Y. (*Advancement*)

Myrick, J. W. H., Lt. Col. (Retired), Div. of Smoke Inspection, The Commonwealth of Massachusetts, Boston, Mass. (*Reinstatement.*)

Norris, William P., Assoc. Engr., U. S. District Engineers Office, Galveston, Tex. (*Advancement*)

Oberschulte, Richard H.,. Sales & Field Engr., D. T. Randall & Co., Detroit, Mich. (*Advancement*)

O'Neill, Joseph F., Mech. Engr., Trane Co. of Canada, Ltd., Toronto, Ont., Canada.

Schulz, Walter F., Senior Partner, Schulz & Norton, Memphis, Tenn.

Simonds, Chauncey A., Owner, Grand Rapids, Mich.

Toupin, Valerien, Htg. Engr., Municipal Buildings Dept., Montreal, Que., Canada.

Wagenbrenner, L. H., Chief Mech. Engr., Ralph E. Phillips, Los Angeles, Calif.

Watson, Charles E. W., Pres., John Watson & Co., Ltd., Westmount, Que., Canada.

Wellford, Walker L., Jr., Secy., Chickasaw Wood Products Co., Memphis, Tenn.

Whybrew, George H., Chief Mech. Engr., Giffels & Vallet, Inc., Detroit, Mich.

Woodson, Edward G., Mgr., The Trane Co., Memphis, Tenn.

ASSOCIATES

Bigelow, F. H., Branch Mgr., Ilg Electric Ventilating Co., Memphis, Tenn.

Bock, I. I., Carrier-Bock Co., Dallas, Texas. (*Reinstatement*)

Boles, Harry S., Mgr., Mid-State Frozen Egg Corp., Indianapolis, Ind.

Butler, Robert P., Partner, Kerr Machinery Co., Detroit, Mich

Conover, Donald D., Gas Repr., Philadelphia Electric Co., Chester, Pa.

Cosgrove, James J., Wholesale Mgr., LaSalle Coke Co., Montreal Que., Canada.

Goodwin, Frank T., Repr., Forest City Foundries Co., Grand Rapids, Mich.

Labadie, William, Supt. Estimating, Universal Plumbing & Heating Co., Toronto, Ont., Canada.

Lewis, J. C., Factory Repr., Drayer & Hanson, Inc., & Farr Co., Bellaire, Tex.

Orr, Weldon J., Draftsman, James A. Kearns, Montreal, Que., Canada.

Otis, Alfred L., Dist. Sales Mgr., Clarage Fan Co., West Hartford, Conn.

Shea, Francis X., Eastern Repr., Farr Co., New York, N. Y.

Sidbury, Roy W., Sales Engr., Chase Brass & Copper Co., Waterbury, Conn.

Smith, Howard W., Jr., Engr., Southern California Telephone Co., Los Angeles, Calif.

Smith, Norman A., Pres., Norman A. Smith Co., Toronto, Ont. Canada.

Wesby, Vernon L., Chief Operating Engr., Utilities Operating Dept., Electro-Motive Div., General Motors Corp., La Grange, Ill.

Williams, Oliver L., Distr., Bryant Heater Co., Pittsburgh, Pa.

Wright, Jack, Owner, Canadian Plumbing & Heating Specialties, Ltd., Montreal, Que., Canada.

JUNIORS

Nelson, Norris T., Vtg. Engr., Bethlehem Steel Co., San Francisco, Calif.

Porter, Frank, Owner, Porter Engineering Co., Silver Spring, Md

Smith, Vernon D., Draftsman, A. M. Kinney, Inc., Cincinnati, Ohio.

Officers

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First Vice-President....................C.-E. A. Winslow
Second Vice-President....................Alfred J. Offner
Treasurer....................L. P. Saunders
Secretary....................A. V. Hutchinson
Technical Secretary....................Carl H. Flink

Council

S. H. Downs, *Chairman* C.-E. A. Winslow, *Vice-Chairman*

Three Years: C. M. Ashley, L. T. Avery, L. E. Seeley, G. D. Winans.

Two Years: J. F. Collins, Jr., James Holt, E. N. McDonnell, T. H. Urdahl.

One Year: W. A. Danielson, L. G. Miller, A. E. Stacey, Jr., B. M. Woods, M. F. Blankin, G. L. Tuve, *Ex-Officio.*

Council Committees

Executive—A. J. Offner, *Chairman;* E. N. McDonnell, A. E. Stacey, Jr.

Finance—B. M. Woods, *Chairman;* L. E. Seeley, T. H. Urdahl, L. P. Saunders, *Ex-Officio.*

Membership—M. F. Blankin, *Chairman;* J. F. Collins, Jr., G. D. Winans.

Meetings—C.-E. A. Winslow, *Chairman;* L. T. Avery, L. G. Miller.

Standards—L. P. Saunders, *Chairman;* C. M. Ashley, James Holt.

Advisory Council

M. F. Blankin, *Chairman;* Homer Addams, D. S. Boyden, W. H. Carrier, S. E. Dibble, W. H. Driscoll, E. O. Eastwood, W. L. Fleisher, H. P. Gant, F. E. Giesecke, E. Holt Gurney, L. A. Harding, H. M. Hart, C. V. Haynes, E. Vernon Hill, John Howatt, W. T. Jones, D. D. Kimball, G. L. Larson, S. R. Lewis, Thornton Lewis, J. F. McIntire, F. B. Rowley and A. C. Willard.

Nominating Committee

Chapter	Representative	Alternate
Atlanta	T. T. Tucker	I. B. Kagey
Cincinnati	G. V. Sutfin	H. A. Pillen
Connecticut	H. E. Adams	Stanley Hart
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Golden Gate	R. A. Folsom	C. E. Bentley
Illinois	E. M. Mittendorff	A. O. May
Indiana	G. B. Supple	J. G. Hayes
Iowa	C. W. Helstrom	W. W. Stuart
Kansas City	D. M. Allen	W. A. Russell
Manitoba	F. L. Chester	William Glass
Massachusetts	E. G. Carrier	R. T. Kern
Michigan	S. S. Sanford	W. H. Old
Minnesota	R. C. Jordan	F. B. Rowley
Montreal	T. H. Worthington	A. B. Madden
Nebraska	D. E. McCulley	B. G. Peterson
New York	R. A. Wasson	C. S. Koehler
North Carolina	Arvin Page	P. L. Guest, Jr.
North Texas	G. A. Linskie	E. T. Gessell
Northern Ohio	L. S. Ries	John James
Oklahoma	E. T. P. Ellingson	
Ontario	V. J. Jenkinson	W. C. Kelly
Oregon	E. C. Willey	
Pacific Northwest	M. N. Musgrave	J. D. Sparks
Philadelphia	H. B. Hedges	Edwin Elliot
Pittsburgh	T. F. Rockwell	E. H. Riesmeyer, Jr.
St. Louis	G. B. Rodenheiser	C. F. Boester
South Texas	J. A. Walsh	A. B. Banowsky
Southern California	Leo Hungerford	W. O. Stewart
Washington, D. C.	F. A. Leser	W. H. Littleford
Western Michigan	C. H. Pesterfield	J. W. Miller
Western New York	S. M. Quackenbush	S. W. Strouse
Wisconsin	A. S. Krenz	M. W. Bishop

Officers of Local Chapters

Atlanta: Organized, 1937. Headquarters, Atlanta, Ga. Meets, First Monday. President, M. M. Crout, 412 Houston St., N. E. Secretary, L. L. Barnes, 3995 N. Stratford Rd.

Cincinnati: Organized, 1932. Headquarters, Cincinnati, O. Meets, Second Tuesday. Honorary President, Capt. C. E. Hust. President, G. V. Sutfin, 1005-6 American Bldg., Cincinnati 2. Secretary, A. W. Edwards, 626 Broadway, Rm. 307, Cincinnati 2.

Connecticut: Organized, 1940. Headquarters, New Haven, Conn. President, L. A. Teasdale, 20 Ashmun St. Secretary, Winfield Roeder, 405 Temple St.

Delta: Organized, 1939. Headquarters, New Orleans, La. Meets, Second Tuesday. President, L. V. Cressy, 423 Baronne St., New Orleans 13. Secretary, J. S. Burke, 317 Baronne St., New Orleans 9.

Golden Gate: Organized, 1937. Headquarters, San Francisco, Calif. Meets, First Wednesday. President, C. L. Peterson, 2 Indian Rock Path, Berkeley. Secretary, James Gayner, 260 California St., San Francisco 11.

Illinois: Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, A. O. May, Room 925, 53 W. Jackson Blvd., Chicago 4. Secretary, C. M. Burnam, Jr., Room 1605, 6 N. Michigan Ave., Chicago 2.

Indiana: Organized, 1943. Headquarters, Indianapolis, Ind. Meets, Fourth Friday. President, W. C. Bevington, 730 Indiana Pythian Bldg. Secretary, C. W. Stewart, 1001 York St.

Iowa: Organized, 1940. Headquarters, Des Moines, Ia. Meets, Second Tuesday. President, W. W. Stuart, 417 9th St. Secretary, L. E. Hedeen, 1421 Bertch, Waterloo.

Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets, First Monday. President, D. M. Allen, 215 Pershing Rd., Kansas City 8. Secretary, R. E. Bade, 1102 Commerce Bldg.

Manitoba: Organized, 1935. Headquarters, Winnipeg, Man. Meets, Third Thursday. President, Einar Anderson, 152 Bannerman Ave. Secretary, F. T. Ball, 810 9th Ave., W., Calgary, Alta.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, D. M. Archer, 143 Federal St., Boston 10. Secretary, C. W. Larson, 184 Sycamore St., Roslindale.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, W. H. Old, 1761 Forest Ave. W., Detroit 8. Secretary, A. E. Knibb, 1003 Maryland Ave., Detroit 30.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, F. W. Legler, 17 W. 28th St. Secretary, F. H. Schernbeck, 1057 10th Ave. S. E.

Montreal: Organized, 1936. Headquarters, Montreal, Que. Meets Third Monday. President, A. M. Peart, 637 Craig, W. Secretary, Leo Garneau, Room 832, Dominion Square Bldg.

Nebraska: Organized, 1940. Headquarters, Omaha. Meets, Second Tuesday. President, B. G. Peterson, 6235 Florence Blvd. Secretary, D. E. McCulley, 1101 Jackson St., Omaha 8.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, C. S. Koehler, 4374 Richardson Ave., New York 66. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, F. E. P. Klages, 1034 Jefferson Standard Bldg., Greensboro. Secretary, W. L. Hunken, 707 Guilford Bldg., Greensboro.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, L. C. McClanahan, 603 Great National Life Bldg. Secretary, E. J. Stern, 701 Burt Bldg., Dallas 1.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, O Meets, Second Monday. President, D. L. Taze, 1302 Swetland Bldg., Cleveland 15. Secretary, R. H. Cutting, 3795 Glenwood Rd., Cleveland Heights.

Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, E. T. P. Ellingson, 314 Savings Bldg., Oklahoma City 2. Secretary, G. T. Donceel, Oklahoma Natural Gas Co.

Ontario: Organized, 1922. Headquarters, Toronto, Ont. Meets, First Monday. President, A. S. Morgan, 156 Glenmanor Dr. Secretary, H. R. Roth, 57 Bloor St., W.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, E. C. Willey, Oregon State College, Corvallis. Secretary, G. H. Risley, 516 S. W. Oak St., Portland 4.

Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, M. N. Musgrave, 2019 Third Ave., Seattle 1. Secretary, J. D. Sparks, 7331 W. Green Lake Way, Seattle 3.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, A. C. Caldwell, 550 So. 48th St., Philadelphia 43. Secretary, J. O. Kirkbride, Fourth and Locust Sts., Philadelphia 6.

Pittsburgh: Organized. 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, T. F. Rockwell, Carnegie Institute of Technology, Schenley Park. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, G. B. Rodenheiser, 4431 Finney Ave., St. Louis 13. Secretary, B. L. Evans, 571 Stratford Ave., University City.

South Texas: Organized, 1938. Headquarters, Houston, Texas. Meets, Third Friday. President, A. B. Banowsky, 3735 Ingold, Houston 5. Secretary, B. P. Fisher, Box 92, Houston 1.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, Leo Hungerford, 3485 Wonderview Pl., Los Angeles 28. Secretary, Arthur Theobald, 336 North Foothill Rd., Beverly Hills, Calif.

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, J. W. Markert, 8506 Garfield St., Bethesda, Md. Secretary, A. S. Gates, Jr., 111 County Rd., Kensington, Md.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, C. H. Pesterfield, Michigan State College, East Lansing. Secretary, V. H. Hill, 2111 Colvin Court, Lansing 10.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, S. W. Strouse, 493 Franklin St., Buffalo 2. Secretary, G. E. Adema, 39 W. Balcom St.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, I. J. Haus, 3880 N. Richards St., Milwaukee 1. Secretary, M. W. Bishop, 231 W. Wisconsin Ave., Milwaukee 3.